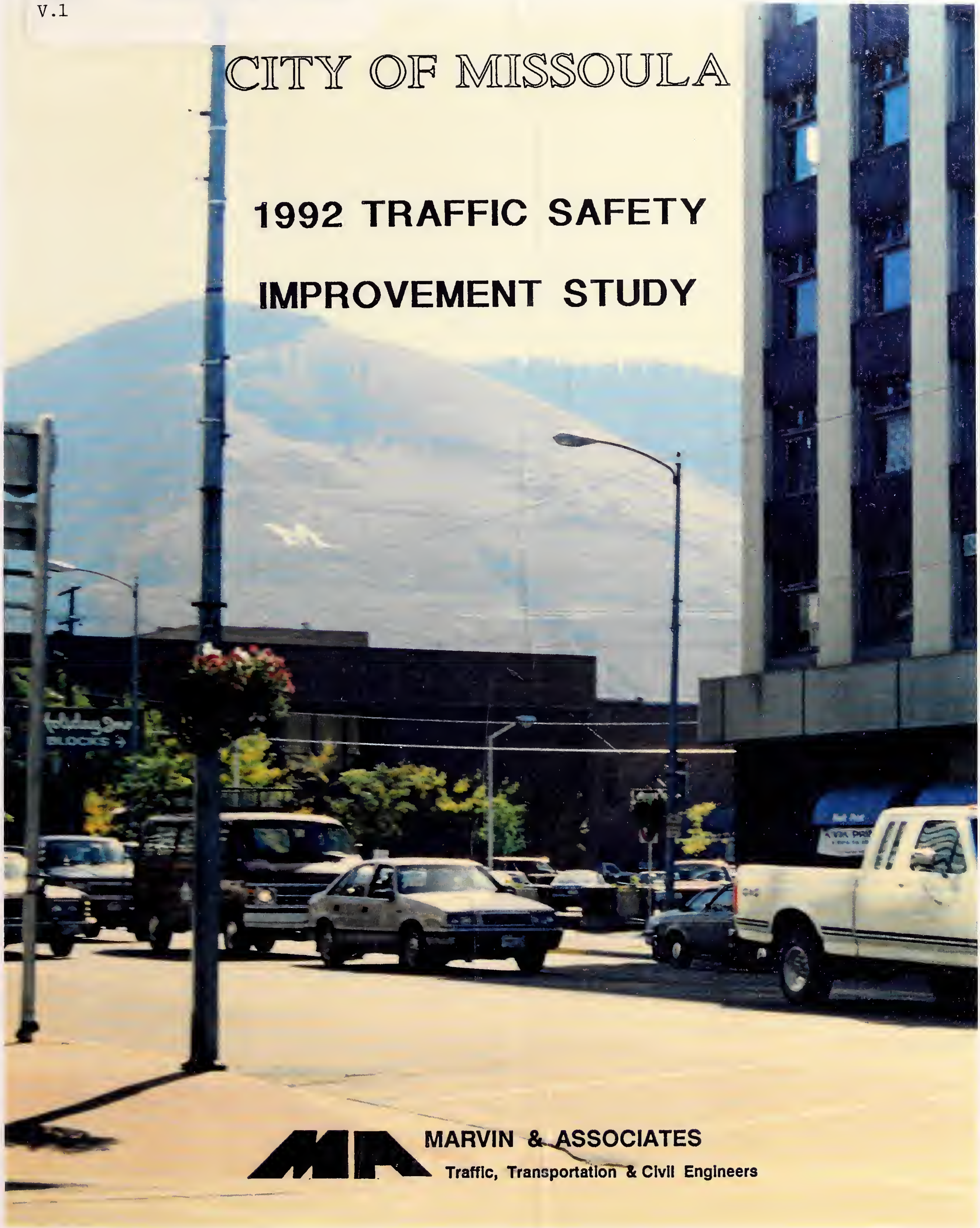
CITY OF MISSOULA

1992 TRAFFIC SAFETY IMPROVEMENT STUDY



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TRAFFIC SAFETY

IMPROVEMENT STUDY

PREPARED FOR

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INTRODUCTION

STUDY PURPOSE

The City of Missoula, in an effort to reduce or otherwise alleviate problems at accident cluster sites on the City street system, retained the Consulting Engineering Firm of Marvin & Associates to perform a traffic engineering study. The purpose of this study was to identify accident cluster locations, collect and analyze pertinent data, make short and long term safety improvement recommendations and establish a priority list of improvement projects.

Other studies using similar methods have been completed for Montana counties with the technical and financial assistance of the Montana Department of Justice, Highway Traffic Safety Division. The intent of the Highway Traffic Safety Division in sponsoring studies on county roads was to reduce accidents on county road systems and to establish an awareness of accident reduction measures so that a continuation of the program could be established within each county. In 1991, Highway Traffic safety shifted its emphasis to city street systems. The first two studies, completed in 1991, validated the analysis methods as applied to city street systems and this study represents a continuation of these efforts.

Since most major cities in Montana have traffic engineers or technicians on staff and are benefited by other safety programs, the intent of the safety improvement study is somewhat different than those completed in Montana counties. Much of major urban area street systems are designated as Federal Aid Routes. The classifications range from Primary Highways to Federal Aid Urban streets. These streets are usually urban arterials and collectors which have high traffic volumes. Monitoring accident data and traffic volumes; developing improvement projects; planning new facilities; and maintaining the system, is usually handled by the City and State. Programs such as the TSM Element of the Transportation Planning Process and the Montana Department of Transportation's Safety Program adequately cover most of the safety problems within Montana's major cities. Day-to-day operations

on the street system cover accident problem areas as they are brought to the attention of the city staff through citizen complaints or police requested investigations. Thus, this study is focused on those locations which may not be included in any of the formal State or City programs. Most of the accidents sites are on streets which do not fall under federal aid classifications and are commonly known as "Off-system" streets. Some of the study sites may be at locations that the City has implemented controls in the past, but have defied efforts at improving safety. The majority of sites are usually low volume streets which have had minor, but consistent accident problems. Because of a low number of accidents per year, these locations are not readily recognized as accident cluster sites. When subjected to intense analysis, as contained in this study's methods, large benefits from simple inexpensive improvements can be recognized. Thus, the purpose of this study is to identify accident cluster sites on city streets; recommend improvements; prioritize site improvements; and introduce cities to the methods used in this type of analysis.

The methodology used in this study, which primarily serves as the basis for the analysis, can be found in report *No. FHWA-RD-77-83 "Identification of Hazardous Locations"*. Refinements to the FHWA report made by *DCA Project No. 79-04-01-0*1 and subsequent county studies throughout the state, are also incorporated within this report. The methodology used to establish priority rankings is explained in the Benefit/Cost Ratio section of this report and is tailored specifically to the City of Missoula's unique requirements.

Traffic safety improvements contained within this report will qualify for the Montana Department of Transportation, Off-system Safety Funds. Because of this, priorities and funding obligations are specifically tailored to MDoT requirements. Upon approval by the City of Missoula, this report should be submitted to MDoT as justification for Off-system Safety fund allotments.

REPORT ORGANIZATION

The initial section of this report contains narratives describing the accident cluster site locations, characteristics of the city street system, study methodology, results of the hazard index analysis for all of the sites, explanation of the improvements recommended, priority index calculations, an implementation schedule and recommendations for continuation of the program in future years. Special attention should be given to the Site Characteristics and Explanation of Improvements sections, since specific traffic safety information for the Missoula street system is presented in these sections.

Site specific data can be found within the individual site sections following the main body of this report. Site specific sections contain brief narratives regarding site conditions, observed problems, and recommendations. Also included is an accident summary page, 35mm pictures of the site, and supporting information as required.

A great deal of computer generated data was printed and reduced for inclusion on the existing condition and short term improvement sketches. The availability of pertinent data on the same page as the sketches hopefully aids in comprehension of the problem identification and improvement benefits. The short term plan sketches can also be used by the MDoT to verify the traffic control device items eligible for funding through their program. These sketches, being too voluminous for inclusion within this report, are bound separately as a plan package and titled "Volume II". Any references to existing conditions or short term improvements within this report can be found in the that document. The 11"x17" plan sketch book can also be used by the City Street Department in the future, for actual implementation of most improvements.

The site specific sections of this report are numbered according to their priority ranking as indicated in the site location section of this report. Twenty five (25) sites are included in this project, as per the contract budget. Some of the sites were located in close proximity along single streets. In addition, other sites identified during the screening process indicated that some streets have accident

problems at almost every intersection and significant numbers between intersections. At these locations a general evaluation of the corridor appeared to be warranted. However, most of these corridors were already included in long range plans for reconstruction and other general improvement projects which would preclude the use of short term improvement strategies. Garfield Street was initially considered a candidate for corridor analysis, but during the course of this study it was discovered that each of the accident sites on Garfield were independent in nature and no specific corridor related problems were directly involved.

In one case, a significant number of intersections west of the university appeared as accident cluster sites. Carl Thompson, Traffic Superintendent, City of Missoula, indicated that these intersections were similar in nature and that a corridor evaluation would be more productive than analyzing a number of individual sites. Therefore, this area was evaluated as a corridor and is further discussed within the main body of this report.

SITE CHARACTERISTICS

SITE LOCATIONS

The map on the following page (Figure 1.) shows the twenty five accident sites numbered according to their respective priority numbers. Table 1., below, is a listing of site numbers corresponding to the site locations:

TABLE 1. LIST OF STUDY SITES

PRIORITY SITE NO.	INTERSECTION STREETS	
1	DEARBORN	GARFIELD
2	FAIRVIEW	GARFIELD
3	CONNELL	HELEN
4	CALIFORNIA	FOURTH
5	FLORENCE	EDITH
6	GARFIELD	NINTH
7	PLYMOUTH	FLORENCE
8	GARFIELD	TENTH
9	COOLEY	DICKENS
10	GARFIELD	FOURTH
11	FAIRVIEW	WASHBURN
12	CHESTNUT	THIRD
13	FRONT	PATTEE
14	MAIN	RYMAN
15	COTTONWOOD	THIRD
16	COTTONWOOD	SIXTH
17	MOUNT	CLEVELAND
18	JOHNSON	FOURTEENTH
19	STEPHENS	KENT
20	KENT	OXFORD
21	MYRTLE	FOURTH
22	PHILLIPS	COWPER
23	ARTHUR	BECKWITH
24	SPRUCE	McCORMICK
25	SCOTT	PHILLIPS

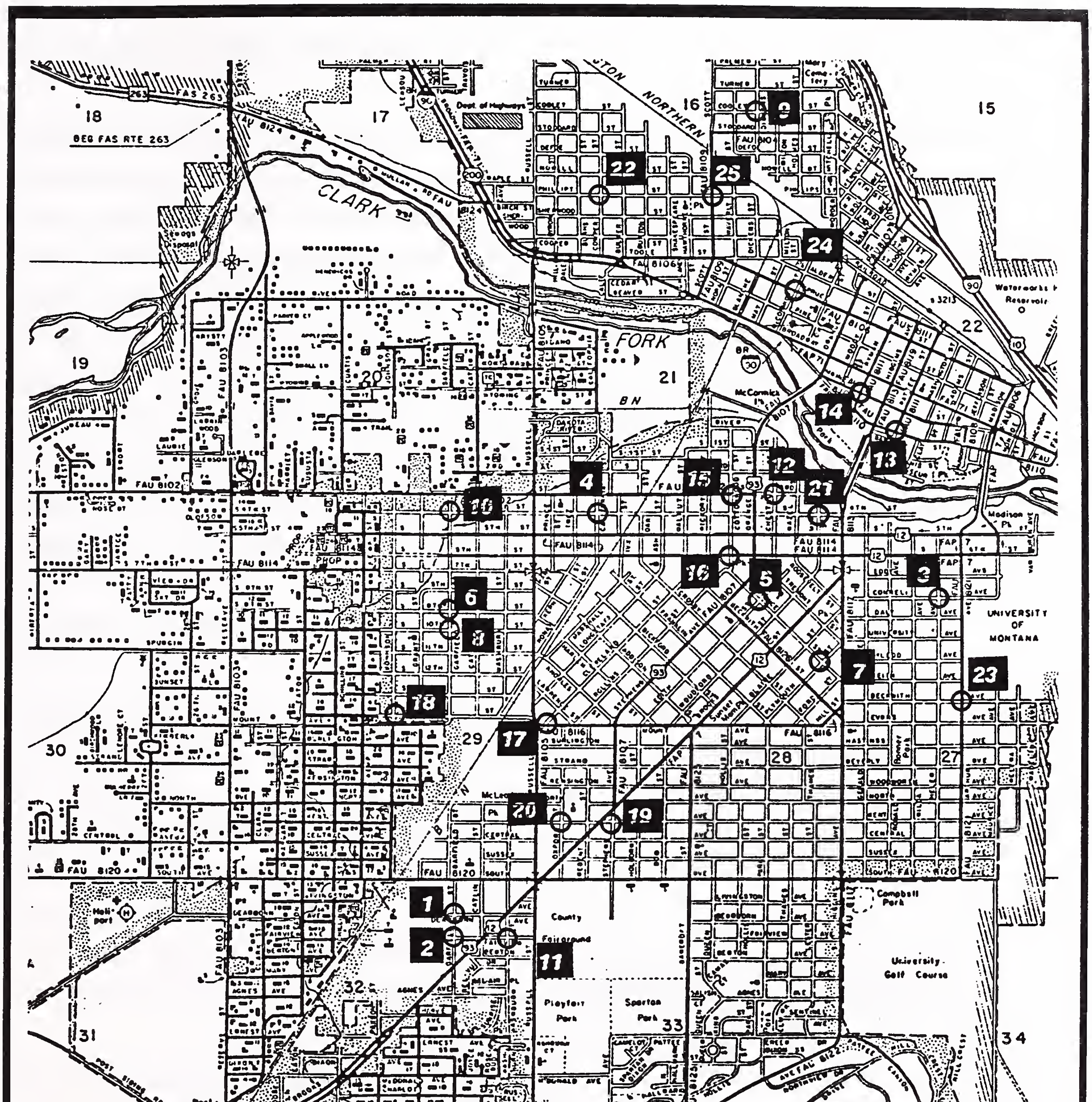


FIGURE 1. SITE LOCATION MAP

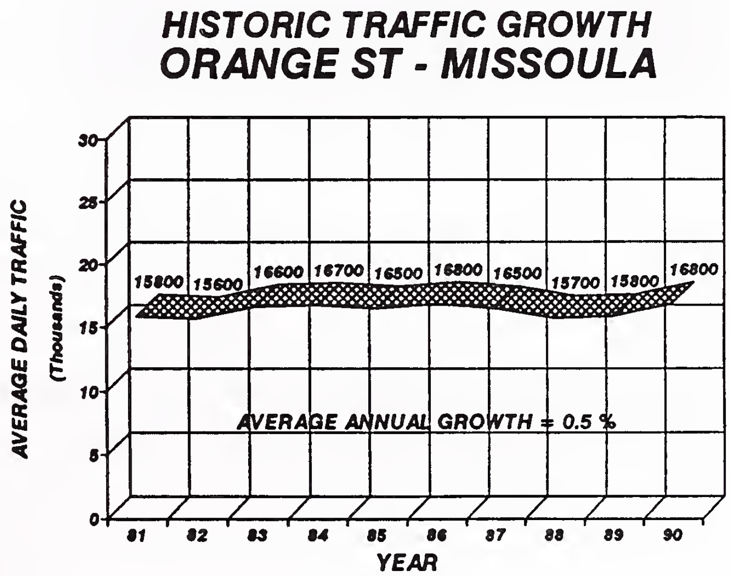
SYSTEM CHARACTERISTICS

Traffic Volumes - The majority of accident sites are located in a completely urban environment on relatively low volume streets. The highest traffic volume at any site is approximately 14,100 vehicles per day entering an intersection, while the lowest volume is approximately 500 vehicles per day entering. The average of all sites is approximately 5,400 vehicles per day entering. Average Daily Traffic (ADT) on all of the streets involved is approximately 2,700 and ranges between 10,000 and 150. The City of Missoula has a continuous counting program and numerous past traffic counts were available at or near the study sites. The Montana Department of Transportation monitors traffic at a permanent count station on Orange Street in Missoula. Information taken from this count station was used to develop monthly and daily traffic variation factors in estimating ADT's at the study sites.

Historical Factors

Data provided by the City of Missoula indicated that traffic volumes on city streets have remained fairly constant over the past four years. Within the past year, traffic volumes have begun to increase at a number of locations. MDoT's permanent count station provided the most reliable indication of traffic growth in the urban area, historically. Data from that station provides general, long range trends in traffic growth.

Figure 2. illustrates traffic growth on Orange Street during the past nine years. Generally, traffic is growing at an annual of approximately 0.5% per year.

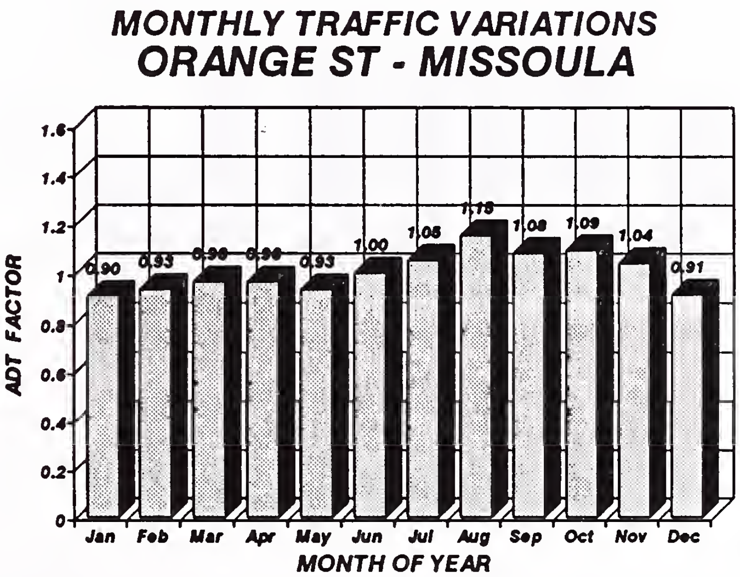


Monthly Variations

A key factor in estimating average daily traffic is the month of the year. Traffic tends to vary significantly depending on the weather, seasonal economy, school sessions and various other reasons. Monthly variations provide an accurate reflection of seasonal conditions.

Figure 3. illustrates monthly traffic variations for the count station on Orange Street in Missoula. This data was extracted from MDoT's permanent count station records.

This figure indicates normal variations between months of the year with August being the highest volume month, with approximately 115% of average monthly traffic. January is the lowest traffic month with ADT's being about 90% of the average month.



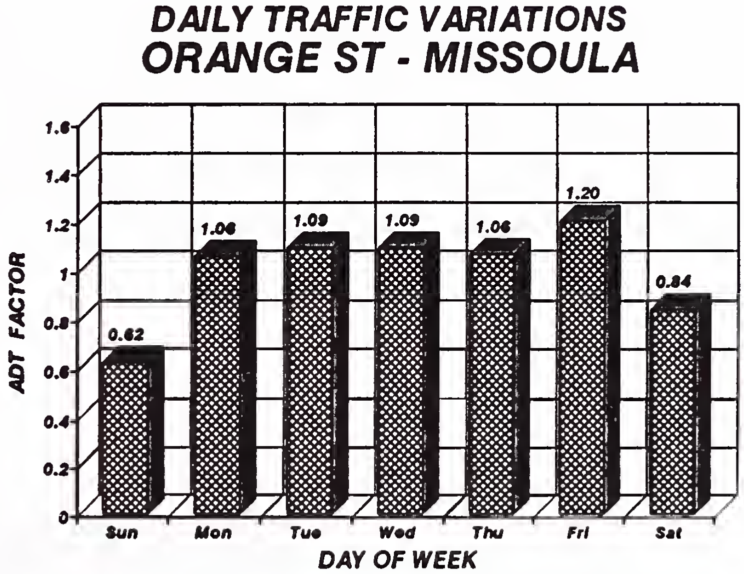
The University of Montana's influence on area street traffic can be seen in this figure. In other major Montana cities, traffic peaks in June or July and drops dramatically in the fall. This graph indicates a heavy influx of traffic in the fall, with no decline until December.

Daily Variations

Traffic volumes vary significantly according to the day of the week and play an important role in estimating average daily traffic. Factors derived from extended traffic counts are not usually as reliable as monthly or seasonal factors due to the smaller time frame. Special holidays and events tend to skew daily variations. As an example, Monday holidays tend to have lower traffic than normal while the following Tuesday has higher than normal traffic.

Figure 4., right illustrates daily traffic variations in Missoula. This data was again extracted from MDoT's permanent count Station.

There appears to be a significant increase in Friday Traffic Volumes, 20% higher than the average daily traffic. Saturday and Sunday traffic is dramatically smaller than weekday traffic.

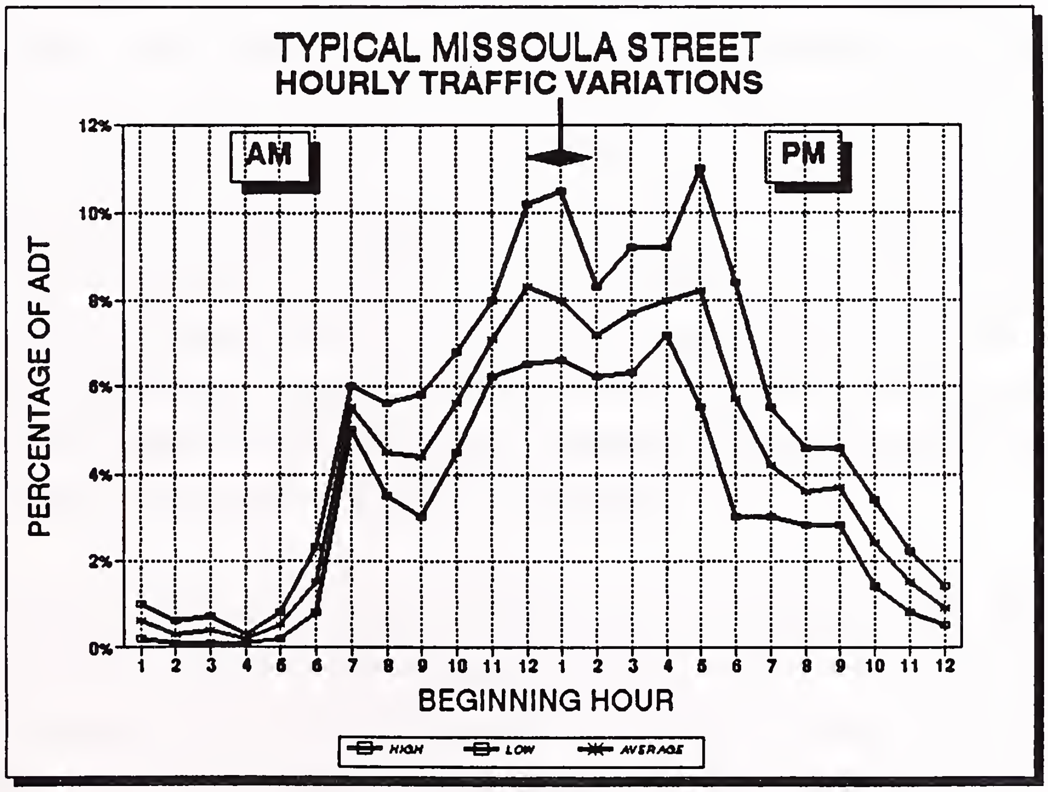


Since Orange Street is a north-south arterial street serving specific types of trips, the above representation of daily traffic variations may not be 100% accurate for other streets in the city. Streets near the shopping mall would not be expected to carry only 84% of ADT on Saturday, but would probably be closer to 100% of ADT. Local and residential street would probably have similar differences in daily variations, but the magnitude would be smaller. As such, Fridays would experience about 110% of ADT and Saturdays would have 90% of ADT.

Hourly Variations

Variations in traffic volumes by time of the day is highly predictable since there is usually no significant differences from one weekday to the next, at any one location. However, differences between various types of streets and locations can be vastly dissimilar. Twenty four hour machine recording counts on the same or similar streets are necessary to accurately estimate ADT's from shorter period counts.

Figure 5., below, presents hourly traffic variations for a range of street types within Missoula. Ten different count stations at or near the study sites were used to develop the high and low range of hourly variations. As such, Figure 5. only indicates typical hourly variations, with the middle line representing an average. Similar graphs were developed for each street counted and were used to estimate ADT on applicable streets and to predict peak hour volumes for capacity analysis and control device warrants.



Street Characteristics - The Missoula city street system is laid out with three separate grid orientations. The original downtown grid system runs parallel to the Clarks Fork River. A quarter section of land in the middle of the urban area has streets laid out parallel to Brooks Street and the remainder of Missoula is based on a north-south grid. While a mixture of grid orientations is common in many cities, Missoula's street geometry is further complicated by Brooks (formerly US 93) which is the major arterial traversing the city at a 45 degree angle to the north-south grid. This orientation creates many six legged intersections and mini islands of land. Unusual intersection geometry has posed many traffic problems for Missoula in the past. Unique solutions have been necessary to deal with the unusual street geometry, the most significant of which have occurred in the past decade. A channelization project on Brooks Street has significantly improved traffic flow along that corridor. However, necessary turn restrictions and access control has altered circulation patterns for adjacent land access. The altered circulation patterns have undoubtedly increased traffic on side streets adjacent to Brooks. Several of the study sites are located within the influence of the Brooks Street circulation patterns.

Missoula, also known as the "Garden City", has more than its share of trees, shrubs and other greenery. Most areas of the city are replete with large mature trees in and along boulevard areas. Missoula is apparently up to the challenge of maintaining clear vision zones within its street environment. Considering the potential for signs and devices being obscured by vegetation, there were very few areas where obvious problems existed. It is evident that trees have been trimmed to afford sight distance at signs throughout the entire city. At those locations where vegetation does restrict sight distance, the blockage was not total and sometimes not very obvious. Judging from the informational report developed by the Missoula Traffic Safety Task Force regarding visibility obstruction information and distributed by the City, the problem of adequate sight distance is receiving primary importance. For this, the City of Missoula should be commended.

While the City of Missoula does an excellent job of keeping trees trimmed, tree trunks in the boulevard areas are so large that they sometimes create an intermittent sight restriction which may or may not be related to some of the angle accidents. These type of blind spots can sometimes be more hazardous than a large

imposing sight restriction because motorists are not consciously aware of the brief loss of sight.

Physical characteristics of the streets are similar to most western cities. There is a mixture of old and new street design features. Surface conditions are better than most cities, with very few locations having surfaces rough enough to be an influence on accident experience. In addition, streets and alleys are immaculate which is evidence of an aggressive maintenance program. Streets void of debris aid in longevity of pavement markings and provide maximum friction interface between the road and the vehicle, which is critical for accident avoidance.

Parking - One of the few problems found with the Missoula street system during this study was the amount of angle parking area in existence. Angle parking is never consistent with traffic safety and efficiency. The only time angle parking should be allowed along any street is when the negative impacts are totally compensated by benefits from additional parking spaces. In most cases, the insurance of a positive trade-off is difficult to achieve. Many of the study sites have evidence of accidents occurring, either directly or indirectly, because of angle parking. Recommendations made within this report do not include conversion of angle parking to parallel, simply because demand was not known. However, it was observed that adequate parking supply seems to be a problem throughout the urban area, especially in the older sections of the city. This observation is based on the large numbers of vehicles parked along the streets.

As a general recommendation, the City of Missoula should evaluate existing angle parking areas and determine if these areas are truly justified. A study completed for the City of Butte, by Marvin & Associates, to determine feasibility of angle parking contains angle parking warrant analysis procedures. A copy will be provided to Carl Thompson, Traffic Superintendent, for informational purposes.

Driver & Vehicles - Missoula drivers tend to be more aggressive than what would be expected within a city of its size. This is probably due to a younger driver population and heavy concentrations of traffic in most areas of the city. Start-up time and headways at signals appear to be as fast as most larger metropolitan

areas. The majority of drivers are cognizant of modern traffic control devices and the proper use of lane control features. Vehicle speeds appear to be faster than the speed limit. At some locations, the upper range of pace speeds exceed the normal 5 mph variation. These are probably areas which may were not included in a recent speed zone study since they are not on arterials and are covered by ordinance, not posted limits.

Missoula also has a higher than average use of the bicycle as a transportation mode. Counts at the study sites indicate overall bicycle traffic in a range between 0.5% and 20% of total entering traffic. During a full college session and nice weather, those percentages probably would increase dramatically. Also, pedestrian traffic appears to be much higher than in other Montana cities. Fortunately, pedestrian and bicycle accidents were not indicated as major problems at the study sites.

Traffic Control Devices - Some degree of traffic control devices were present at almost all of the sites. The applications range from street name signs to traffic signals. Most of the signs and markings were applied correctly according to the Manual on Uniform Traffic Control Devices (MUTCD). Street signs appear to be in good condition at almost all of the sites. One of the most positive aspects of the Cities' signage was positive guidance on the street system. All study locations had street name signs mounted in relatively consistent locations, where possible. Lack of such signing can become a major safety problem for motorists not familiar with Missoula. In this situation, a large portion of the drivers cognitive powers are directed toward navigation. When there is little positive guidance provided, critical driving mistakes can be committed because little conscious ability remains for the other varied driving tasks.

Some damaged and faded signs were noted throughout the city. While not a very large percentage of total signs fall into that category, it is important to replace signs which become ineffective. The City of Missoula should develop, if it hasn't already, a complete sign inventory and management system. Through this system, signs are replaced on a priority basis as budget allows. It is recommended that

the City develop a program which allows all signs, regardless of priority, to be replaced after a maximum period of time in the sign's life.

One particular problem observed deals with the placement of stop signs and it has more to do with street geometry than choice of location. On streets with wide boulevards, stop signs are placed on the approach side of sidewalks, probably to protect pedestrian crossing movements. Some boulevards are as wide as twenty five feet, which places the stop sign well behind the actual point of the vehicle stop. This creates a number of problems. According to state law, no parking is allowed within 30 feet of the stop sign. If marked correctly, parking would be prohibited for a distance of 55-60' from the corner radius on the approach. However, parking restrictions are usually marked 30 feet from the radius which results in parking within 5 to 10 feet of the stop sign. Also, pedestrians would normally cross behind a stopped vehicle and in heavy traffic situations this can be become very dangerous. No easy or inexpensive solutions can be suggested concerning this problem on a city wide basis.

Local, low volume streets are mostly devoid of any type of pavement markings. On some higher volume, two lane, local and collector type streets it was noted that a dashed yellow or skip mark line was used to define the centerline. In an urban area where intersections are separated by 500 feet or less, this is an improper application of pavement markings. If a centerline is used a solid line must be used to prohibit passing at intersections. Urban intersections are too closely spaced to allow anything other than a double solid line as a centerline. The dashed line may be assuming some liability for improper passing maneuvers.

Another positive aspect regarding traffic control devices in Missoula is the obvious attention given to no parking zones at intersections. Yellow curb restrictions are in evidence at the majority of the study sites. Even though there are several areas where additional length is required because of higher traffic volumes and difficult geometry, the curb markings are consistent and well maintained.

There are numerous traffic signal installations within the City of Missoula. Most of

those signals are on the Federal Aid System. While several problems could be cited with some of the On-system signal installations, there are only a few minor problems with the City's signals that can be noted. Most of these problem are directly related to the age of the systems involved. Numbers and sizes of signal heads could be increased at some locations.

Traffic Accidents

Traffic accident characteristics for all of the Missoula study sites are summarized below:

Category	Total	Average Per Site
Total Number of Sites	25	NA
Total Number of Accidents	212	8.50
Study Period in Years	4.0	4.0
Traffic Volumes Entering	NA	5400
Accident Rate /MVE	NA	2.46
No. of Injuries	70	2.80
No. of Fatalities	0	0
Severity in 1000's $	1096	51.70
No. Angle Accidents	136	5.44
No. Rear End Accidents	20	0.80
No. Sideswipe Accidents	19	0.76
No. Pedestrian Accidents	3	0.12
No. Single Vehicle Accidents	5	0.20
No. Left turn Accidents	15	0.60
No. Parked Car Accidents	12	0.48
No. of Other Type Accidents	2	0.08

Of all the years in this period, 1989 had the least number of accidents (39), while 1991 had the most with 65. The predominant trend appears to be increasing accidents at the study sites. This can be explained, somewhat, by increasing traffic volumes. Angle accidents were the most common accident type, which accounts

for the relatively high number of injuries. Most of the accidents occurred in clear weather on dry roads. Night time accidents were not as common as accidents in daylight hours. No fatal accidents occurred within the study sites. The average accident rate per site of 2.46/mve is higher than the typical intersection, as would be expected. Eight of the accident sites had accident rates less than 1.0, which may be low for intersections included in this type of study.

Future System Characteristics - Missoula has an approved transportation plan which outlines certain transportation improvement projects to be constructed within the next twenty years. None of the short term improvements recommended within this report would have any significant effect on the implementation of long range transportation projects. Some of the study sites provide short term solutions to problems which would be better served by more capital intensive long range projects or by projects having more far reaching effects than those served by short term improvements. Specific long range recommendations are made in the site specific sections of this report when applicable.

STUDY METHODOLOGY

The study was segregated into four distinct phases which best achieved the purpose and scope of the traffic study. These phases are outlined as follows:

Phase 1, Site Selection - involved copying all of the accident reports on Missoula city streets for the years 1988 thru of 1991 from Department of Justice files in Helena, Montana. The state reports were sorted and arranged by Avenues and Streets and then cross referenced by intersection. Major, on-system streets and primary highways, such as Brooks, Broadway and Russell were discarded in the process. The reports were then screened for locations having 5 or more accidents during the reporting period. Cross referenced accidents were confirmed and then entered into a computer program to calculate preliminary hazard index values.

Number of accidents, accident rates and severity indexes were calculated for fifty three cluster sites. Table 2 is a summary of the screening program. The cluster sites were ranked according to the composite value of three indexes. A recommended list of sites was given to Carl Thompson, Traffic Superintendent, City of Missoula, for his review and approval. The list was modified due to current and local knowledge of projects in progress and projects that had recently been completed. Mr. Thompson had a thorough knowledge of the site characteristics and provided a very selective list of the final study sites.

Phase 2, Data Collection - included preliminary organization of the project including scheduling, site location, form processing, field data collection and reduction of data. Accident data was obtained from reports provided by the Department of Justice. Traffic counts were taken at each location. The existing average daily traffic was determined by applying factors for hourly, daily and monthly variations. Other data collected in the field, included measurement of road widths and geometrics, and inventory of traffic control devices, turning movement counts and subjective observation of traffic operations. DJA Engineering of Missoula performed the field topo surveys, sign inventories and base sheet drafting.

TABLE 2. CITY OF MISSOULA - ACCIDENT SITE SCREENING LIST
RANKING BY COMPOSITE ACCIDENT FACTOR

SITE RANK NO.	INTERSECTION WITH AVENUE or STREET	STREET OR AVENUE	ACCIDENTS / YEAR 88	69	90	91	TOTAL NO. ACC.	NO. ACC. INDEX	APPROX. VOLUME	ACC. RATE	ACC. RATE INDEX	SVRT INDEX	COMPOSITE SCREEN INDEX	REMARKS
1	HILLVIEW	BLACK PINE	3	2	4	0	9	64	2400	2.68	52	66	60.0	
2	BLAINE	FLORENCE	1	4	2	1	8	81	1600	3.57	85	52	59.5	
3	FAIRVIEW	GARFIELD	8	3	10	5	24	90	7500	2.29	46	48	59.0	
4	ARTHUR	BECKWITH	2	1	3	1	7	58	1500	3.34	62	54	58.0	
5	CONNELL	HELEN	1	1	4	4	10	67	2200	3.25	60	44	56.8	
6	DEARBORN	GARFIELD	3	3	3	2	11	69	5000	1.57	34	72	56.5	
7	RESERVE	DEARBORN	8	7	8	4	27	92	17000	1.14	26	59	55.3	FAU
8	COOLEY	DICKENS	0	1	4	1	6	54	1500	2.86	55	58	55.1	
9	DALY	GERALD	2	2	2	1	7	58	1600	3.13	59	48	54.8	
10	CALIFORNIA	FOURTH	1	1	1	2	5	50	1200	2.94	57	52	53.2	
11	GARFIELD	TENTH	1	1	1	3	6	54	1900	2.38	48	58	52.3	
12	EDDY	HILDA	0	2	3	1	8	54	2400	1.79	38	66	51.8	
13	RESERVE	SOUTH	8	9	10	8	31	95	26000	0.85	20	52	51.8	FAU
14	RESERVE	SCHRAM	2	8	1	2	13	74	14000	0.66	18	74	51.8	FAU
15	KENT	OXFORD	1	1	5	2	9	64	3000	2.14	44	48	51.4	
16	JOHNSON	FOURTEENTH	2	6	7	2	17	81	8800	1.38	31	50	51.2	
17	DALY	HELEN	2	1	3	2	8	61	2800	2.04	42	51	50.4	
18	GARFIELD	NINTH	1	0	1	4	6	54	1900	2.38	48	49	50.1	
19	MAURICE	HASTINGS	3	0	1	1	5	50	1500	2.38	48	52	49.7	
20	PHILLIPS	COWPER	2	0	2	1	5	50	1500	2.38	48	52	49.7	
21	FLORANCE	EDITH	2	1	1	1	5	50	1800	1.99	41	59	49.6	
22	TREMONT	BLAINE	0	1	1	3	5	50	2200	1.82	35	65	49.2	
23	FRONT	PATTEE	3	4	1	6	14	76	8000	1.67	36	41	48.9	
24	EDDY	HELEN	0	4	3	0	7	56	2400	2.06	43	48	48.7	
25	MAIN	RYMAN	3	4	6	0	13	74	7000	1.33	30	49	48.3	
28	JOHNSON	FIFTH	2	2	1	1	8	54	2800	1.53	33	81	48.2	
27	COTTONWOOD	SIXTH	1	1	2	1	5	50	1600	1.99	41	52	47.2	FAU
28	ARTHUR	McCLEOD	0	3	1	1	5	50	1500	2.38	48	44	47.2	
29	MAIN	PATTEE	2	0	5	5	12	72	7000	1.23	28	43	45.2	
30	RESERVE	MULLAN	0	1	6	5	12	72	15000	0.57	14	58	45.0	FAU
31	PLYMOUTH	FLORENCE	1	0	4	0	5	50	1800	1.99	41	54	44.7	
32	GARFIELD	FOURTH	3	1	0	1	5	50	2000	1.79	38	44	43.4	
33	COTTONWOOD	THIRD	0	3	1	2	6	54	6000	0.71	18	65	43.3	FAU
34	RESERVE	CENTRAL	0	0	7	5	12	72	14000	0.81	15	52	43.3	FAU
35	WALNUT	SIXTH	1	1	2	1	5	50	3500	1.02	24	60	43.2	FAU
36	FAIRVIEW	WASHBURN	3	1	1	0	5	50	3200	1.12	26	58	43.2	
37	EATON	SOUTH	1	1	5	5	12	72	7400	1.18	27	38	43.0	FAU
38	KEMP	SOUTH	1	1	3	5	10	67	12000	0.60	15	55	42.7	FAU
39	RYMAN	SPRUCE	1	4	0	2	7	58	4500	1.11	26	48	41.9	FAU
40	SPRUCE	McCORMICK	1	2	2	2	7	58	4500	1.11	26	48	41.9	FAU
41	RONAN	FOURTEENTH	0	1	1	3	5	50	6000	0.60	15	64	41.0	
42	MYRTLE	FOURTH	2	2	0	1	5	50	2600	1.43	32	44	40.9	
43	STEPHANS	KENT	2	0	2	6	10	67	9000	0.79	19	44	40.8	
44	KENSINGTON	BOW	0	1	3	1	5	50	2000	1.79	38	33	39.7	
45	SOUTH	SCHILLING	0	1	4	3	8	61	7500	0.76	19	48	39.6	FAU
46	CHESTNUT	THIRD	2	1	0	2	5	50	6000	0.60	15	58	39.0	FAU
47	RUSSELL	SECOND	1	3	4	2	10	67	18000	0.40	11	48	38.7	FAU
48	FRONT	RYMAN	0	3	0	3	8	54	7000	0.61	15	51	37.9	
49	MOUNT	CLEVELAND	3	0	1	1	5	50	5600	0.65	16	52	37.4	FAU
50	SCOTT	PHILLIPS	1	2	2	2	7	58	4500	1.11	26	33	37.1	
51	RESERVE	STOCKYARD	3	0	3	1	7	58	12000	0.42	11	49	36.8	FAU
52	RUSSELL	WYOMING	0	0	0	5	5	50	18000	0.20	6	59	35.6	FAU
53	JOHNSON	SOUTH	0	1	2	2	5	50	16000	0.22	6	44	31.1	FAU
		TOTALS =	86	103	149	123	461							
		AVE. YEAR =	1.8	1.9	2.8	2.3	8.7	60.4	8141.5	1.6	32.7	52.1	48.8	

NOTE: 1991 Accidents only include the months of January thru October

Composite Index: Number Accidents = 28%, Accident Rate= 39%, Severity = 33%

Phase 3, Analysis of Data - included the determination of hazard indexes for each location by using the Federal Highway Administration Report *No. FHWA-RD-77-83 "Identification of Hazardous Locations".* Computations involved with accidents, volumes, capacities, indicator values and other aspects of hazard indexes were performed on a microcomputer using original templates for Ouattro Pro Ver. 4.0, developed by Marvin & Associates. Regression equations were developed to mathematically simulate hazard index curves contained in the FHA report. From these computations a preliminary hazard ranking list was prepared.

Phase 4, Evaluation of Corrective Measures - included the determination of improvements that would reduce or eliminate certain types of accidents or accidents in general at the study locations. Preliminary designs of those improvements included signing, geometric changes, and some minor reconstruction. The improvements were recommended on a short term basis. In most cases, the nature of the sites were such that long term improvements would not provide additional benefits beyond those expected through implementation of short term improvements.

Cost effectiveness calculations of the improvements at each location were determined by preparing preliminary cost estimates and computing economic benefits to arrive at a benefit/cost ratio. Specific information regarding the B/C ratio can be found on pages 37 through 42 of this report. The method used to determine benefit/cost ratios is identical to that used by the Montana Department of Transportation Project Planning Section. All values used in the formulation were supplied by Hank Butzlaff, supervisor of that section. The composite hazard index ranking and benefit/cost ratio, then determined the final priority listing.

HAZARD INDEX ANALYSIS RESULTS

Seven hazard indexes were used as the preliminary basis of ranking hazardous sites. The following are brief descriptions of each index including data format, data collection, indicator scaling and site ranking with respect to each index.

1. **Number of Accidents** - This indicator provides a historical background of accidents at the investigation site. In the case of Missoula, a four year period was used, which included 1988 thru 1991. The accident reports were photo copied in Helena and provided to the consultant. The data represents all reports filed within the city limits of Missoula.

Figure 6. is a curve extracted from the FHWA report which was used to determine the indicator value. The data base is number of accidents per year. This indicator, as with all of the seven indicators used in the report, is scaled between 0 and 100. An average of two accidents per year in a three year period indicates a hazardous location (indicator value of 33). An average of ten accidents per year is used to designate a very hazardous location (indicator value of 67). In the case of this study, the total number of accidents per site criteria was used to extract the index value rather than the annual rate. This higher value is therefore more consistent with the level of the other index values. Using an annual rate would have scaled down the importance of this indicator relative to other index values. Table 3. is the computer generated ranking of all sites based on this indicator. It can be seen that none of the sites exceeded the maximum value of 100 and the average value of 60.3 was in the same range as other hazard index values.

2. **Accident Rate Indicator** - This indicator somewhat compensates for any incomplete information provided by the number of accident indicator in that an exposure value is provided by the relationship between accidents and the total volume of vehicles using the facility. This indicator is expressed as the number of accidents per million entering vehicles. In the case of an intersection, "million entering vehicles" is the sum of the daily average approach volumes on all legs of the intersection, multiplied by the number of days in the analysis period.

TABLE 3. SITE RANKING BY NUMBER OF ACCIDENTS

RANK NO.	AVENUE	STREET	ACCIDENTS / YEAR 88	89	90	91	TOTAL NO. ACC.	NO. ACC. INDEX
1	FAIRVIEW	GARFIELD	6	2	10	7	25	91
2	JOHNSON	FOURTEENTH	2	6	7	2	17	81
3	FRONT	PATTEE	3	3	1	6	13	74
4	DEARBORN	GARFIELD	3	3	3	3	12	72
5	MAIN	RYMAN	3	4	5	0	12	72
6	STEPHENS	KENT	2	0	2	7	11	69
7	CONNELL	HELEN	1	1	4	4	10	67
8	KENT	OXFORD	1	1	4	3	9	64
9	ARTHUR	BECKWITH	2	1	3	2	8	61
10	GARFIELD	NINTH	1	0	1	6	8	61
11	SPRUCE	McCORMICK	1	2	2	3	8	61
12	FAIRVIEW	WASHBURN	3	1	1	2	7	58
13	PLYMOUTH	FLORENCE	1	0	4	2	7	58
14	SCOTT	PHILLIPS	1	3	1	2	7	58
15	COOLEY	DICKENS	0	1	4	1	6	54
16	COTTONWOOD	THIRD	0	3	1	2	6	54
17	GARFIELD	TENTH	1	1	1	3	6	54
18	CALIFORNIA	FOURTH	1	1	1	2	5	50
19	CHESTNUT	THIRD	2	1	0	2	5	50
20	COTTONWOOD	SIXTH	1	1	2	1	5	50
21	FLORENCE	EDITH	2	1	1	1	5	50
22	GARFIELD	FOURTH	3	1	0	1	5	50
23	MOUNT	CLEVELAND	3	0	1	1	5	50
24	MYRTLE	FOURTH	2	2	0	1	5	50
25	PHILLIPS	COWPER	2	0	2	1	5	50
		TOTALS =	47	39	61	65	212	
		AVERAGES =	1.9	1.6	2.4	2.6	8.5	60.3

The accident rate indicator is a very important part of the hazard index ranking method and data collection is possible when a continued program of traffic counting has been performed. Spot counts adjusted by yearly volume increases, seasonal variations, daily variations and hourly variations were necessary at most of the sites to develop an average daily traffic figure applied to the analysis period.

Figure 7 represents the graphic plot of accident rate versus indicator value. As before, the indicator value ranges between 0 and 100. Table 4 is the computer generated ranking of sites based on this indicator. It can be seen that the intersections included in this study produced a wide range of accident rates commensurate with large differences in traffic volumes. The average rate index was 42.

3. Accident Severity Indicator - Although there are many factors involved in the severity of accidents, statistical studies over a significant number of years have given fairly reliable dollar values in terms of economic loss for each type of accident. The accident severity indicator correlates a probable cause and effect relationship which aids in the determination of the level of accident reduction measures required. Severity values can also be used as a determinant of benefits resulting from various improvements. The data base for accident severity is average relative severity in thousands of dollars. Data collection necessary for the use of the severity index is made possible by the accident report form. Dollar values for severity were provided by Hank Butzlaff of the Montana Department of Transportation. They are: Fatal Accident = $500,000, Injury Accident = $11,000 and Property Damage Accident = $2,000. Recently, the method of calculating fatal and injury costs was changed by MDoT to include total number of persons injured or killed rather than just an injury or fatal accident as a single incident. In the case of this study, some single accidents produced multiple injuries which increased the relative severity of those sites significantly.

The FHWA report presents the relative severity index values for each type of accident. Once the type of accident has been established, Figure 8 enables the user to assess the indicator value. Figure 8 is a graphic plot of the average severity in thousands of dollars versus the indicator value which is based on a scale of 0 to 100. Table 5 is the computer generated ranking of sites based on this indicator.

TABLE 4. SITE RANKING BY ACCIDENT RATE

RANK NO.	STREET/AVE	STREET/AVE	NO. ACC. 4.00 YEARS	1991 ADT	ADT PERIOD AVE.	AC. RATE (MVE)	ACC RATE IND VALUE
1	CONNELL	HELEN	10	850	850	8.06	100
2	GARFIELD	NINTH	8	725	725	7.56	100
3	FLORENCE	EDITH	5	525	525	6.52	96
4	PLYMOUTH	FLORENCE	7	775	775	6.19	93
5	CALIFORNIA	FOURTH	5	600	600	5.71	89
6	GARFIELD	TENTH	6	925	925	4.44	76
7	COOLEY	DICKENS	6	1350	1350	3.04	58
8	FAIRVIEW	GARFIELD	25	6400	5760	2.97	57
9	FRONT	PATTEE	13	6300	5670	1.57	34
10	GARFIELD	FOURTH	5	2250	2200	1.56	34
11	DEARBORN	GARFIELD	12	6350	5715	1.44	32
12	CHESTNUT	THIRD	5	2800	2520	1.36	30
13	MYRTLE	FOURTH	5	2800	2520	1.36	30
14	PHILLIPS	COWPER	5	2775	2700	1.27	29
15	FAIRVIEW	WASHBURN	7	4800	4320	1.11	26
16	COTTONWOOD	SIXTH	5	3450	3105	1.10	25
17	MAIN	RYMAN	12	8400	7560	1.09	25
18	JOHNSON	FOURTEENTH	17	13850	12465	0.93	22
19	KENT	OXFORD	9	9050	8145	0.76	18
20	STEPHENS	KENT	11	11350	10215	0.74	18
21	SPRUCE	McCORMICK	8	8575	7718	0.71	17
22	SCOTT	PHILLIPS	7	7800	7020	0.68	17
23	COTTONWOOD	THIRD	6	8100	7290	0.56	14
24	ARTHUR	BECKWITH	8	14100	12690	0.43	11
25	MOUNT	CLEVELAND	5	10600	9540	0.36	10
		AVERAGE VALUE	8	5420	4916	2.46	42

TABLE 5. SITE RANKING BY ACCIDENT SEVERITY

RANK NO.	AVENUES	STREETS	SUM OF SEVERITY VALUES	TOTAL NO. ACC.	AVERAGE SEVERITY INDEX	INDICATOR VALUE
1	DEARBORN	GARFIELD	$146,000	12	$12,167	70
2	FLORENCE	EDITH	$39,000	5	$7,800	58
3	CHESTNUT	THIRD	$37,000	5	$7,400	57
4	COOLEY	DICKENS	$41,000	6	$6,833	55
5	GARFIELD	TENTH	$41,000	6	$6,833	55
6	ARTHUR	BECKWITH	$54,000	8	$6,750	55
7	COTTONWOOD	THIRD	$39,000	6	$6,500	54
8	FAIRVIEW	WASHBURN	$41,000	7	$5,857	52
9	CALIFORNIA	FOURTH	$28,000	5	$5,600	51
10	COTTONWOOD	SIXTH	$28,000	5	$5,600	51
11	MOUNT	CLEVELAND	$28,000	5	$5,600	51
12	PHILLIPS	COWPER	$28,000	5	$5,600	51
13	JOHNSON	FOURTEENTH	$88,000	17	$5,176	50
14	KENT	OXFORD	$45,000	9	$5,000	49
15	FAIRVIEW	GARFIELD	$115,000	25	$4,600	48
16	GARFIELD	NINTH	$34,000	8	$4,250	46
17	MAIN	RYMAN	$51,000	12	$4,250	46
18	CONNELL	HELEN	$38,000	10	$3,800	44
19	GARFIELD	FOURTH	$19,000	5	$3,600	44
20	MYRTLE	FOURTH	$19,000	5	$3,600	44
21	FRONT	PATTEE	$44,000	13	$3,385	42
22	PLYMOUTH	FLORENCE	$23,000	7	$3,286	42
23	SPRUCE	McCORMICK	$25,000	8	$3,125	41
24	STEPHENS	KENT	$31,000	11	$2,818	39
25	SCOTT	PHILLIPS	$14,000	7	$2,000	34
		TOTAL SEVERITY $ =	$1,096,000			
		TOTAL NO. ACC. =		212		
		AVE. SEVERITY / ACC. =			$5,170	
		AVE. IND. VAL / SITE =				49

4. **Volume to Capacity Ratio Indicator** - This indicator not only reflects exposure rates but also incorporates existing street geometry, access and conditions such as traffic type, turning directions, volume mix and number of lanes. Computation of the volume capacity indicator is expressed as follows:

V/C = ADT/24 HOUR CAPACITY

Modifications to the basic V/C formula were felt necessary because of the predominance of intersections within this study and the vast changes that have occurred in capacity theory since the time when the FHWA report was published. Use of the original formula would have diluted the relative importance of this indicator if calculated in this manner. Therefore, volume/capacity calculation using the 1985 Highway Capacity Manual procedures were used and expressed as a peak hour V/C. Calculations of peak hour V/C in this manner also gives an indication of intersection efficiency and aids in the development of potential improvements.

Data required for the volume capacity ratio involved field measurements of existing geometrics, turning counts and volume mix. The capacity of each intersection is computed through methodology presented in the 1985 *Highway Capacity Manual* using FHWA computer software. Although this indicator is cumbersome to use by inexperienced personnel, its inclusion is considered necessary and correlates well in hazardous index ranking.

Figure 9. presents a graphic plot of the volume capacity ratio versus the indicator value which is also scaled between 0 and 100. Table 6. is the computer generated ranking of the sites based on this indicator. The average value for this indicator was 50 while values ranged between 6 and 100.

TABLE 6. SITE RANKING BY VOLUME/CAPACITY RATIOS

RANK NO.	STREET/AVE	STREET/AVE	PEAK HOUR CAPACI	PEAK HOUR FLOW	* V/C RATIO	V/C INDICATOR VALUE
1	JOHNSON	FOURTEENTH	0	828	INFIN	100
2	STEPHENS	KENT	181	383	2.12	100
3	KENT	OXFORD	249	372	1.49	100
4	SCOTT	PHILLIPS	444	270	0.61	88
5	FRONT	PATTEE	308	184	0.60	87
6	MOUNT	CLEVELAND	206	115	0.56	83
7	FAIRVIEW	GARFIELD	477	243	0.51	78
8	MAIN	RYMAN	333	169	0.51	78
9	DEARBORN	GARFIELD	710	342	0.48	75
10	ARTHUR	BECKWITH	**	**	0.48	75
11	COTTONWOOD	THIRD	243	96	0.40	65
12	SPRUCE	McCORMICK	176	54	0.31	55
13	FAIRVIEW	WASHBURN	482	120	0.25	47
14	PHILLIPS	COWPER	948	220	0.23	45
15	MYRTLE	FOURTH	694	139	0.20	41
16	COTTONWOOD	SIXTH	516	49	0.09	24
17	GARFIELD	FOURTH	790	70	0.09	23
18	CHESTNUT	THIRD	776	54	0.07	19
19	CONNELL	HELEN	898	41	0.05	14
20	PLYMOUTH	FLORENCE	952	37	0.04	13
21	COOLEY	DICKENS	831	26	0.03	11
22	CALIFORNIA	FOURTH	980	27	0.03	10
23	FLORENCE	EDITH	985	23	0.02	9
24	GARFIELD	NINTH	951	22	0.02	9
25	GARFIELD	TENTH	965	12	0.01	6
		AVERAGE VALUES	564	156	0.37	50

* V/C Refers to capacity of the minor street in the case of uncontrolled or stop/yeild controlled intersections.

** V/C Refers to average v/c for all legs of signalized intersection or a four way stop intersection.

5. **Sight Distance Indicator** - This indicator is of significant value in both rural and urban locations, especially at intersections. Even though the weighting factor in the hazard index computation is low, it is still considered valuable in determining cause and effect relationships and other deficiencies at the accident cluster sites.

The data format for using the sight distance indicator is the ratio of actual sight distance to desirable sight distance. The FHWA report presents the minimum stopping sight distance on wet pavement for the various design speeds. Actual stopping sight distance is the distance from the drivers position to the point where a stop may be required to avoid a hazardous maneuver or direct collision. Required sight distances vary according to the type of control encountered. At uncontrolled intersections specific AASHTO guidelines for this situation are used. At stop controlled and signalized intersections two different requirements are applied: 1. stopping sight distance to the control device & 2. intersection sight distance required to cross the intersection. The various required sight distances and measured values are computed and combined according to the study method's formulation to determine the indicator value.

The data format for this indicator is the sight distance ratio of actual over desirable. Collection of the sight distance data requires field measurements of sight distance and determination of average travel speeds. Figure 10. presents a graphic plot of the sight distance ratio versus the indicator value which ranges from 0 to 100. Table 7. is the computer generated ranking of sites based on this indicator. A total of 2 sites had indicator values of 100 and they ranged down to 28. Considering all of the possible restrictions present in an urban environment, the higher values should not be unexpected.

TABLE 7. SITE RANKING BY SIGHT DISTANCE

RANK NO.	INTERSECTION LOCATION		APP1 SD	REQ SD	RATIO	APP2 SD	REQ SD	RATIO	APP3 SD	REQ SD	RATIO	APP4 SD	REQ SD	RATIO	*WT. IND VAL
1	CHESTNUT	THIRD	50	200	0.25	150	200	0.75	120	300	0.40	140	300	0.47	100
2	COTTONWOOD	THIRD	80	200	0.40	80	200	0.40	130	350	0.37	100	350	0.29	100
3	DEARBORN	GARFIELD	80	200	0.40	200	200	1.00	100	300	0.33	100	300	0.33	100
4	FRONT	PATTEE	60	200	0.30	110	200	0.55	140	300	0.47	150	300	0.50	100
5	FAIRVIEW	WASHBURN	200	200	1.00	40	200	0.20	300	350	0.86	240	350	0.69	100
6	MAIN	RYMAN	150	200	0.75	90	200	0.45	110	300	0.37	120	300	0.40	100
7	JOHNSON	FOURTEENTH	200	200	1.00	70	200	0.35	160	350	0.46	200	350	0.57	100
8	FAIRVIEW	GARFIELD	250	200	1.25	200	200	1.00	120	300	0.40	130	300	0.43	100
9	SCOTT	PHILLIPS	200	200	1.00	200	200	1.00	150	400	0.38	220	400	0.55	100
10	MYRTLE	FOURTH	150	200	0.75	150	200	0.75	120	300	0.40	160	300	0.53	100
11	MOUNT	CLEVELAND	180	300	0.60	200	200	1.00	120	200	0.60	120	300	0.40	100
12	CONNELL	HELEN	150	200	0.75	150	200	0.75	150	300	0.50	150	300	0.50	100
13	STEPHENS	KENT	140	200	0.70	200	200	1.00	120	300	0.40	250	300	0.83	100
14	COOLEY	DICKENS	200	200	1.00	200	200	1.00	140	300	0.47	200	300	0.67	100
15	SPRUCE	McCORMICK	150	200	0.75	150	200	0.75	200	350	0.57	200	350	0.57	92
16	COTTONWOOD	SIXTH	150	200	0.75	150	200	0.75	300	350	0.86	200	350	0.57	79
17	GARFIELD	FOURTH	70	110	0.64	110	110	1.00	90	110	0.82	120	110	1.09	67
18	GARFIELD	TENTH	70	110	0.64	90	110	0.82	110	110	1.00	110	110	1.00	67
19	CALIFORNIA	FOURTH	80	110	0.73	100	110	0.91	110	110	1.00	115	110	1.05	55
20	KENT	OXFORD	200	200	1.00	180	200	0.90	240	300	0.80	240	300	0.80	54
21	PHILLIPS	COWPER	110	110	1.00	110	110	1.00	100	110	0.91	100	110	0.91	42
22	ARTHUR	BECKWITH	500	275	1.82	500	275	1.82	150	200	0.75	250	200	1.25	42
23	FLORENCE	EDITH	100	110	0.91	110	110	1.00	120	110	1.09	110	110	1.00	39
24	PLYMOUTH	FLORENCE	120	110	1.09	120	110	1.09	120	110	1.09	120	110	1.09	28
25	GARFIELD	NINTH	120	110	1.09	130	110	1.18	120	110	1.09	120	110	1.09	28
														AVERAGE INDICATOR VALUE	79.8

* WEIGHTED INDICATOR VALUE IS CALCULATED BY THE FORMULA (2xHIGHVAL + 2ndHIGHVAL)/3

APP# SD's = MEASURED SIGHT DISTANCE ON DIRECTIONAL APPROACHES FOR VARIOUS CONDITIONS OF CONTROL

REQ SD = REQUIRED SIGHT DISTANCE ACCORDING TO AASHO

6. **Driver Expectancy Indicator** - This indicator relates human behavior factors to existing road conditions. The value of this indicator is realized in the fact that the roadway geometrics and roadside culture are evaluated on a human judgement basis.

The data format for the driver expectancy index is the problem rating scale. Being a subjective indicator, the degree of expectancy is rated on a scale from 1 to 6, and the expectancy rating varies linearly with the indicator value as shown in Figure 11. The expectancy rating form can be found in the FHWA report for further reference. Table 8. is the computer generated ranking of sites based on this indicator.

7. **Information System Deficiencies Indicator** - This indicator also provides a value or subjective judgement on the sufficiency of traffic control devices which transfer necessary information to the operator.

The data format for the information system deficiencies indicator is similar to that of the driver expectancy indicator in that a value form is used to provide a rating between 1 and 6. The rating for this indicator is also plotted linearly between the indicator range values of 0 and 100 and is shown on Figure 12. The value rating form is for the information system deficiencies indicator. It is also presented in the FHWA report for further reference. Table 9. is the computer generated ranking of sites based on this indicator.

TABLE 8. SITE RANKING BY DRIVER EXPECTANCY

RANK NO.	AVENUE	STREET	NB RATE	SB RATE	EB RATE	WB RATE	WGTD. RATE	IND VAL
1	FLORENCE	EDITH	6	5	6	6	5.8	96
2	KENT	OXFORD	5	5	5	5	5.0	83
3	GARFIELD	FOURTH	6	6	4	4	5.0	83
4	STEPHENS	KENT	3	6	6	5	5.0	83
5	MYRTLE	FOURTH	5	5	5	5	5.0	83
6	MAIN	RYMAN	4	6		5	5.0	83
7	SCOTT	PHILLIPS	3	3	6	6	4.5	75
8	MOUNT	CLEVELAND	5	3	5	5	4.5	75
9	FAIRVIEW	GARFIELD	4	4	5	5	4.5	75
10	DEARBORN	GARFIELD	4	4	5	5	4.5	75
11	ARTHUR	BECKWITH	4	4	5	4	4.3	71
12	FAIRVIEW	WASHBURN	5	6	3	3	4.3	71
13	JOHNSON	FOURTEENTH	4	4	4	4	4.0	67
14	CONNELL	HELEN	4	4	4	4	4.0	67
15	PLYMOUTH	FLORENCE	5	3	3	5	4.0	67
16	COTTONWOOD	THIRD	4	4	4	3	3.8	63
17	FRONT	PATTEE	4	4	3		3.7	61
18	PHILLIPS	COWPER	3	3	4	4	3.5	58
19	SPRUCE	McCORMICK	3	3	4	4	3.5	58
20	CALIFORNIA	FOURTH	4	3	3	4	3.5	58
21	GARFIELD	TENTH	4	3	3	4	3.5	58
22	COTTONWOOD	SIXTH	3	3	4		3.3	56
23	COOLEY	DICKENS	3	3	3	3	3.0	50
24	GARFIELD	NINTH	3	3	3	3	3.0	50
25	CHESTNUT	THIRD	3	3	3	3	3.0	50
				AVERAGE INDICATOR VALUE =				68.7

TABLE 9. SITE RANKING BY INFORMATION DEFICIENCY

RANK NO.	STREET/AVE	STREET/AVE	NB RATE	SB RATE	EB RATE	WB RATE	WGTD. RATE	IND VAL
1	FRONT	PATTEE	5	5	6		5.3	89
2	FLORENCE	EDITH	5	5	5	5	5.0	83
3	JOHNSON	FOURTEENTH	5	5	5	5	5.0	83
4	COTTONWOOD	THIRD	6	3	5	5	4.8	79
5	MAIN	RYMAN	4	4	0	5	4.3	72
6	ARTHUR	BECKWITH	4	4	5	4	4.3	71
7	CHESTNUT	THIRD	6	5	3	3	4.3	71
8	MOUNT	CLEVELAND	6	3	5	3	4.3	71
9	GARFIELD	FOURTH	3	3	5	5	4.0	67
10	PHILLIPS	COWPER	3	3	5	5	4.0	67
11	KENT	OXFORD	4	4	4	4	4.0	67
12	COTTONWOOD	SIXTH	3	3	3	6	3.8	63
13	CONNELL	HELEN	4	4	3	3	3.5	58
14	CALIFORNIA	FOURTH	5	3	3	3	3.5	58
15	MYRTLE	FOURTH	3	3	4	4	3.5	58
16	DEARBORN	GARFIELD	4	4	3	3	3.5	58
17	STEPHENS	KENT	3	5	3	3	3.5	58
18	FAIRVIEW	GARFIELD	4	4	3	3	3.5	58
19	SPRUCE	McCORMICK	4	4	3	3	3.5	58
20	FAIRVIEW	WASHBURN	3	4	3	3	3.3	54
21	SCOTT	PHILLIPS	3	3	3	3	3.0	50
22	PLYMOUTH	FLORENCE	3	3	3	3	3.0	50
23	GARFIELD	NINTH	3	3	3	3	3.0	50
24	GARFIELD	TENTH	3	3	3	3	3.0	50
25	COOLEY	DICKENS	3	3	3	3	3.0	50
				AVERAGE INDICATOR VALUE =				63.8

HAZARD RANKING

Once all of the data had been collected and the indicator values computed, indicator values and necessary data were transferred to the hazard index computation matrix. Each indicator was weighted in accordance with the FHWA report. The weighting factors are fractional portions of unity. When all nine indicators established in FHWA report are used, the sum of weights is equal to one. In the case of Missoula, two indicators were omitted, the Traffic Conflict Indicator and the Erratic Maneuvers Indicator. Their exclusion from the study was not felt to be any detriment in the ranking of hazardous sites. The use of seven indicators provided an 88.6% confidence in strength of evaluation.

Based on the hazard analysis for each site, a matrix of indicator values and final hazard index ratings was constructed on a Quattro Pro template and a hazard index ranking was completed. Table 10., on the following page, lists this ranking by site number, location, indicator values and hazard index. Also shown is statistical information for the indicator values and hazard index.

By inspecting Table 10., it can be seen that the ranking of individual indicator values do not necessarily have a clear correlation with the final hazard index ranking. The number of accidents, indicator values is the only one which has a reasonable correlation. Since the character of the study sites is relatively homogeneous, this correlation cannot be considered significant with respect to all intersections within Missoula.

Standard deviations among the indicator values is reasonably good except for accident rate, volume/capacity ratio and sight distance indicators. Two of these indicators include traffic volume input and the wide range of values reflect the inclusion of a few high volume intersections among the study sites. The sight distance indicator deviations indicate that the majority of intersections were at a maximum indicator value. Since there are many influences on sight distance within an urban area, it is questioned whether this indicator has any value as a hazard indicator in studies of this type.

TABLE 10. SITE RANKING BY HAZARD INDEX - SUMMARY OF INDICATOR VALUES

RANK NO.			# OF ACC.		ACC. RATE		SEVERITY		V/C RATIO		SIGHT DIST		EXPECT.		INFO DEF.		TOTAL
			IND VAL	PART H.I.	IND VAL	PART H.I.	IND VAL	PART H.I.	IND VAL	PART H.I.	IND VAL	PART H.I.	IND VAL	PART H.I.	IND VAL	PART H.I.	HAZARD INDEX
				Wgt. 16.4%		Wgt. 22.5%		Wgt. 19.1%		Wgt. 8.2%		Wgt. 7.4%		Wgt. 14.9%		Wgt. 11.5%	Wgt 100%
1	FAIRVIEW	GARFIELD	91	14.8	57	12.8	48	9.1	78	6.4	100	7.4	75	11.1	58	6.7	68.3
2	FLORENCE	EDITH	50	8.2	96	21.5	58	11.0	9	0.7	39	2.9	96	14.2	83	9.5	68.1
3	CONNELL	HELEN	67	10.9	100	22.4	44	8.4	14	1.1	100	7.4	67	9.9	58	6.7	66.8
4	DEARBORN	GARFIELD	72	11.7	32	7.2	70	13.3	75	6.2	100	7.4	75	11.1	58	6.7	63.5
5	JOHNSON	FOURTEENTH	81	13.2	22	4.9	50	9.5	100	8.2	100	7.4	67	9.9	83	9.5	62.7
6	FRONT	PATTEE	74	12.1	34	7.6	42	8.0	87	7.1	100	7.4	61	9.0	89	10.2	61.5
7	MAIN	RYMAN	72	11.7	25	5.6	46	8.7	78	6.4	100	7.4	83	12.3	72	8.3	60.4
8	CALIFORNIA	FOURTH	50	8.2	89	19.9	51	9.7	10	0.8	55	4.1	58	8.6	58	6.7	57.9
9	STEPHENS	KENT	69	11.2	18	4.0	39	7.4	100	8.2	100	7.4	83	12.3	58	6.7	57.2
10	PLYMOUTH	FLORENCE	58	9.5	93	20.8	42	8.0	13	1.1	28	2.1	67	9.9	50	5.8	57.1
11	GARFIELD	NINTH	61	9.9	100	22.4	46	8.7	9	0.7	28	2.1	50	7.4	50	5.8	57.0
12	GARFIELD	TENTH	54	8.8	76	17.0	55	10.5	6	0.5	67	5.0	58	8.6	50	5.8	56.1
13	KENT	OXFORD	64	10.4	18	4.0	49	9.3	100	8.2	54	4.0	83	12.3	67	7.7	56.0
14	COOLEY	DICKENS	54	8.8	58	13.0	55	10.5	11	0.9	100	7.4	50	7.4	50	5.8	53.7
15	MOUNT	CLEVELAND	50	8.2	10	2.2	51	9.7	83	6.8	100	7.4	75	11.1	71	8.2	53.6
16	COTTONWOOD	THIRD	54	8.8	14	3.1	54	10.3	65	5.3	100	7.4	63	9.3	79	9.1	53.3
17	FAIRVIEW	WASHBURN	58	9.5	26	5.8	52	9.9	47	3.9	100	7.4	71	10.5	54	6.2	53.1
18	MYRTLE	FOURTH	50	8.2	30	6.7	44	8.4	41	3.4	100	7.4	83	12.3	58	6.7	52.9
19	SCOTT	PHILLIPS	58	9.5	17	3.8	34	6.5	88	7.2	100	7.4	75	11.1	50	5.8	51.2
20	GARFIELD	FOURTH	50	8.2	34	7.6	44	8.4	23	1.9	67	5.0	83	12.3	67	7.7	51.0
21	ARTHUR	BECKWITH	61	9.9	11	2.5	55	10.5	75	6.2	42	3.1	71	10.5	71	8.2	50.8
22	CHESTNUT	THIRD	50	8.2	30	6.7	57	10.8	19	1.6	100	7.4	50	7.4	71	8.2	50.2
23	SPRUCE	McCORMICK	61	9.9	17	3.8	41	7.8	55	4.5	92	6.8	58	8.6	58	6.7	48.1
24	PHILLIPS	COWPER	50	8.2	29	6.5	51	9.7	45	3.7	42	3.1	58	8.6	67	7.7	47.4
25	COTTONWOOD	SIXTH	50	8.2	25	5.6	51	9.7	24	2.0	79	5.8	56	8.3	63	7.2	46.8
	AVERAGE VALUES =		60		42		49		50		80		69		64		56
	STANDARD DEVIATIONS =		11		30		7		33		26		12		11		6

EXPLANATION OF IMPROVEMENTS

The recommended improvements presented within this report are short term improvements which reflect the minimum amount of upgrading or modifications necessary to increase driver expectancy and to update the sites to current standards. Long term improvements are only considered viable when severe conditions at the site prevent short term improvements from completely satisfying the control measures necessary to significantly reduce future problems. Since any long term improvements would be dependant upon significant changes in future traffic operations and most of the sites of this nature are covered by the transportation plan, no specific plans were advanced and no costs or project ranking was completed for long term improvements. However, general recommendations of a long term nature are made within the site specific section when applicable.

Some of the recommended improvements have sufficient latitude so that alternative measures could be suggested during design. The selection of recommended improvements was based on subjective engineering judgement and current traffic control standards. Basis of the recommendations incorporate an understanding of driver psychology, visual input requirements, accident statistics and comparative studies. Some of the recommended improvements may not be directly related to accident prevention, but are required to meet current standards and provide consistent control measures. Specific reasons for recommendations are presented in the site specific section of this report.

Prior to subjecting the proposed improvements to review based on the status quo, it should be remembered that these study sites are probably not characteristic of all Missoula intersections. They have been documented as the highest accident locations in the City, with exception of federal aid designated streets. As such, they require improvement measures not typical of other area intersections. If recommended improvements call for 36" stop signs and centerline striping, it should not be considered as justification for installing larger stop signs or striping centerlines at all other locations. In most cases, 30" stop signs are completely adequate while in some cases, either because of sight restrictions; visual distractions on the horizon; lighting conditions or other various reasons, stop signs are simply not perceived by

the driver. Recommendations for oversize stop signs in this study are made when a visual obstruction is not apparent but there is strong evidence that the stop sign is not being perceived.

Since all of the study sites are recognized accident cluster locations, there is good statistical probability that the majority of accidents are not by chance. Therefore, street and traffic control conditions are likely deficient for expected traffic operations. Some of the deficiencies are entirely obvious once the facts have been examined. Others defy a clear cut answer with regard to cause and effect relationships. In all cases, improvements are geared toward improving the street system by relating to the driver's cognitive abilities. The first means of accomplishing this is to enhance visual perception by insuring a clear line of sight to all important information sources, ie. approaching vehicles and traffic control devices. The second factor related to driving functions is directed at subconscious perception, which is the major factor in driver expectancy. As an example, if a street section appears to be a thru street, based on visual clues such as wide pavement surfaces, minor side street traffic and an uninterrupted view to the horizon, even over-sized stop signs may be ignored. In this case, disruption of the pattern is required. It may take the form of a stop bar, cross walk or centerline striping at a stop controlled intersection. These are all methods of giving visual clues to the driver which subconsciously indicates that the approaching intersection requires actions different than did the previous intersections. Many of the recommended improvements within this study relate to the later means of providing information to the driver.

Recommendations for plastic pavement markings are replete throughout the study. Painted marks may be substituted to substantially reduce the City's cost. However, more intense maintenance will be needed if this alternative is chosen. If the marks are worn most of the time, they will not functioned as planned.

In some instances, yield signs could have been recommended rather than a stop sign. There are many factors which influence this decision. The most important factor is sight distance. If there is a permanent sight obstruction such as a building, yield signs are not considered because their use assumes ability to perceive and react to a potential conflict similar to an uncontrolled intersection. When permanent

sight obstructions do not exist, all mobile obstructions (parked vehicles) must be moved from the clear vision zone and yield signs may be recommended as a first level improvement. The use of yield signs is basically a judgement decision once warranting conditions are met. The City of Missoula does not, as a practise, use yield signs other than at ramp merge areas. Introduction of yield signs at local intersections would be inconsistent with the remaining street system and therefore, not advisable. Thus, all intersection control recommendations within this report do not include yield signs.

Wherever stop signs are recommended at the study sites, the intent is to stop the minor volume street. When these improvements are implemented and there is a reasonable doubt regarding which street has the lower traffic volume, additional data may be obtained and the improvements can be adjusted to stop the minor street, if necessary. If stop signs are installed on the major street, respect for stop signs is degraded and accident potential is increased.

The most common improvement recommendation made within this report is marking of parking restrictions either by painting curbs and/or by installing signs. While Missoula has performed an admirable job of controlling parking near intersections, in most cases, conditions of geometry, traffic volumes and type of parking sometimes require more restriction length than covered by state law or city ordinance. In some cases where parking demand appeared to be high, a dynamic vehicle model was used to estimate critical vehicle gaps and to compute the exact sight distance requirements. Line of sight setbacks were adjusted forward to account for "Urban Creep", which occurs when a driver edges into the traffic lane to see around an obstruction. Parking setbacks, calculated in this manner, tend to produce slightly shorter setback requirements, but still seem excessive in an urban environment with high parking demands.

The improvement sketches, in some cases should not be considered design plans. Some of the more complex drawings are preliminary and are intended to present improvement concepts only in enough detail to provide the measure of control necessary and to provide cost estimates. In some cases, detailed survey data; design analysis; design plans and specifications; and construction layout will be necessary to effectively achieve the improvements.

BENEFIT/COST RATIOS

COSTS

Preliminary cost estimates are developed by applying unit costs to required quantities based either on current prices as tabulated from average bid prices of similar projects or, where applicable, on prices established by Montana Department of Transportation's Project Planning Section. The costs should in no way be considered a quote or final estimate of actual work.

The following are traffic control devices and allowable costs that are eligible for funding by the Montana Department of Transportation through their Off-System Safety Program:

A. Signs:

1.	1 square foot to 6 square feet	- $ 100.00
2.	6.1 square feet to 10 square feet	- $ 140.00
3.	10.1 square feet to 20 square feet	- $ 170.00
4.	supplementary sign on same post	- $ 50.00

B. Delineators:

1.	Design ""A" metal posts	- $ 9.25
2.	Design "A" flexible posts-6'	- $ 20.00
3.	Design "A" flexible posts-27"	- $ 6.00

C. Guardrail:

1.	New "W" Beam rail (per foot)	- $ 8.00
2.	"W" Beam end treatment (each)	- $ 1,000.00
3.	New concrete rail (per foot)	- $ 16.00
4.	New concrete end tapers (per foot)	- $ 16.00

D. Pavement Markings:

1. Pavement Marking Paint (per gal) - $ 15.00
*2. Pavement Marking Plastic (per S.F.) - $ 3.00
*3. Plastic Words & Symbols (per S.F.) - $ 2.00

The Department of Justice and the Montana Department of Transportation are currently evaluating safety improvement costs within urban environments. Since the above noted items do not adequately correlate with the nature of improvements within highly urbanized areas, other funding schemes are now being considered. The plastic pavement marking costs*, listed above, are only an estimate based on current unit bid prices and have not been formally established by MDoT.

Even though Missoula street and traffic crews are capable of performing a good deal of work, costs related to physical changes in the roadway section are based on contract prices in order to correlate with costs requiring contract bid letting. The costs do not include administrative, engineering or field layout for the recommended improvements at sites which would require final design plans. Engineering design will generally be required to produce contract plans and specifications. These costs should be evaluated prior to planning improvement projects requiring bids.

BENEFITS

Estimated benefits are made by applying accident reduction forecasts based on the type of improvement recommended. The forecasts are based on the subjective evaluation by an experienced traffic engineer. This evaluation is aided by knowledge of accident experience at similar locations with the improvements existing. Also statistical studies relating certain improvements to accident reduction are used as a guide ie, Roy Jorgenson and Associates, *"Evaluation of Criteria for Safety Improvements on the Highway" (Washington, D.C.: U.S. Bureau of Public Roads, Office of Highway Safety, 1966. p. 316) and "The 1989 Annual Report on Highway Safety Improvement Programs", DOT, p 23.*

The forecasted reduction is expressed as a percentage of each type of accident. This percentage is multiplied by the percentage of all accidents represented by each type. The total percent reduction of all accidents at each site is the sum of all accidents reduction percentages for each type.

The method used to compute benefits in this study follows the Montana Department of Transportation's procedures. Those procedures were programmed by Marvin & associates for Quattro Pro Computer Software which provides a tabular summary of all variables in the computation.

If applied consistently, the economic benefit computation will provide a realistic estimate of average economic savings to society. The benefit amount should not be interpreted as a dollar value that Missoula will receive as a result of dollar outlay. It is a figure used to quantify the economic benefit to society that would occur if a certain number of accidents did not occur.

B/C RATIO

The B/C provides a numerical reference to the relative value of the recommended improvements. It is the desire of any improvement project to have a benefit-cost (B/C) ratio in excess of 1.0. If the B/C is less than 1.0 the project would have questionable justification. In this study, none of the sites had a B/C less than one.

Table 11 is a computer generated summary of the B/C ranking for the twenty five study sites. From this table, it can be seen that the total capital cost of improvements would be approximately $171,000 or about $6,800 per site. The total projected benefit would be approximately $ 203,000, annually. The average B/C ratio value was computed to be approximately 13, which translates into a 1300% return on investment.

B/C indicator values ranged between 10 and 81. The average value for all sites was 46. An explanation of the B/C indicator value is given in the priority index section of this report.

TABLE 11. SITE RANKING BY BENEFIT/COST RATIOS

RNK #	SITE LOCATION		PRO LIFE	COSTS CAPITOL COST IMPROVE	EQUIV ANNUAL COST	ANNUAL MAINT. COST CH.	TOTAL ANNUAL COST	BENEFITS Q	Afi	Apd	PFI	Ppd	ANNUAL BENEFIT	B/C RATIO	IND VAL
1	CALIFORNIA	FOURTH	5	$410	$108	$41	$149	$18,150	0.50	0.75	60%	60%	$6,242	41.85	81
2	DEARBORN	GARFIELD	7	$3,771	$775	$200	$975	$18,150	3.00	1.75	62%	60%	$36,041	36.98	78
3	GARFIELD	NINTH	5	$595	$157	$60	$216	$18,150	0.50	1.50	50%	37%	$5,477	25.30	70
4	PLYMOUTH	FLORENCE	5	$425	$112	$60	$172	$18,150	0.25	1.50	60%	60%	$4,154	24.14	69
5	CONNELL	HELEN	5	$815	$215	$82	$296	$18,150	0.50	2.00	50%	44%	$5,975	20.15	65
6	GARFIELD	FOURTH	5	$595	$157	$60	$216	$18,150	0.25	1.00	70%	70%	$4,311	19.92	65
7	FAIRVIEW	GARFIELD	7	$4,920	$1,011	$200	$1,211	$18,150	1.75	4.75	56%	62%	$22,649	18.71	64
8	CHESTNUT	THIRD	7	$880	$181	$88	$269	$18,150	0.75	0.50	33%	50%	$4,965	18.47	63
9	COOLEY	DICKENS	5	$900	$237	$90	$327	$18,150	0.75	1.00	35%	60%	$5,778	17.65	62
10	GARFIELD	TENTH	12	$2,010	$295	$100	$395	$18,150	0.50	1.00	60%	60%	$6,472	16.38	61
11	FAIRVIEW	WASHBURN	5	$1,155	$305	$116	$420	$18,150	0.75	1.00	40%	40%	$6,166	14.67	58
12	FLORENCE	EDITH	12	$4,750	$697	$100	$797	$18,150	0.75	0.75	70%	33%	$10,098	12.67	55
13	COTTONWOOD	SIXTH	5	$1,021	$269	$102	$371	$18,150	0.50	0.75	40%	37%	$4,127	11.11	52
14	COTTONWOOD	THIRD	5	$4,785	$1,262	$250	$1,512	$18,150	0.75	0.75	70%	25%	$10,006	6.62	41
15	MOUNT	CLEVELAND	7	$1,590	$327	$150	$477	$18,150	0.50	0.75	25%	33%	$2,693	5.65	38
16	PHILLIPS	COWPER	5	$1,200	$317	$100	$417	$18,150	0.25	1.00	35%	23%	$1,972	4.73	34
17	FRONT	PATTEE	12	$8,900	$1,306	$200	$1,506	$18,150	0.50	2.75	53%	36%	$6,421	4.26	31
18	MAIN	RYMAN	12	$10,900	$1,600	$200	$1,800	$18,150	0.75	2.25	40%	44%	$7,069	3.93	30
19	SPRUCE	McCORMICK	12	$7,845	$1,151	$175	$1,326	$18,150	0.25	1.75	60%	44%	$3,955	2.98	24
20	MYRTLE	FOURTH	12	$6,670	$979	$220	$1,199	$18,150	0.25	1.00	60%	48%	$3,511	2.93	23
21	ARTHUR	BECKWITH	12	$21,990	$3,227	$100	$3,327	$18,150	1.00	1.25	47%	32%	$9,313	2.80	22
22	KENT	OXFORD	7	$7,725	$1,587	$200	$1,787	$18,150	0.75	1.50	33%	17%	$4,972	2.78	22
23	STEPHENS	KENT	12	$8,980	$1,318	$120	$1,438	$18,150	0.25	2.50	50%	38%	$3,768	2.62	21
24	JOHNSON	FOURTEENTH	10	$63,470	$10,329	$800	$11,129	$18,150	1.50	2.75	80%	73%	$25,287	2.27	18
25	SCOTT	PHILLIPS	12	$4,805	$705	$150	$855	$18,150	0.00	1.75	0%	51%	$1,366	1.60	10
	TOTALS :			$171,107	$28,627	$3,962	$32,589						$202,787		
	AVERAGES :		8.12	$6,844	$1,145	$158	$1,304				50%	45%	$8,111	12.85	46

PRIORITY INDEX

The ranking of site improvement priorities cannot be directly dependent on the hazard ranking of the study sites. The value of the improvements must enter into the priority listing in the form of the benefit/cost ratio (B/C). The method of developing a composite Hazard Index - B/C listing must be dependent on the relative index scale used in the hazard index computation. Therefor, a correlation of scale between the B/C ratio and hazard indicator value was developed on the following assumptions:

1. The contributing conditions creating hazards at each site and the resulting hazard ranking is relatively independent of the cost of correcting these conditions.
2. Benefits to be derived from correcting hazardous situations at each site is indirectly proportional to the degree of hazards encountered.
3. The benefit/cost ratio, by virtue of benefit computation, is indirectly proportional to the number of accidents indicator and severity indicator, both of which are curvilinear functions.
4. The benefit/cost ratios can be rated on a scale of 0 to 100 based on a curvilinear function.
5. The B/C ratio of 1.0 is equivalent to an indicator value of 0 and the upper limit (indicator value = 100) must be chosen to encompass the majority of sites.

In this case, a B/C of 100.0 and above assumes the indicator value of 100. Based on these assumptions a graphic plot of the B/C ratio versus B/C indicator value has been established and it is shown in Figure 13. Since it has been graphed on semi-log paper the line appears linear.

Since the relative weighting of benefit/costs and hazard indexes is a controversial subject which would require research beyond the scope of this report, it is felt that the priority index should be based on 33% weighting for the benefit-cost ratio and 67% weight on the hazard index. Therefore, to establish a priority index the following formula has been devised:

$$\text{Priority Index} = (\text{Hazard Index}) \times (0.67) + (\text{Benefit/Cost Indicator}) \times (0.33)$$

Table 12. is the computer generated summary of priority ranking based on the composite hazard index - benefit/cost index values.

TABLE 12. SITE RANKING BY PRIORITY INDEX - SUMMARY

PRIORITY NUMBER	AVENUE	STREET	HAZARD INDEX	WEIGHTED VALUE	BEN/CO INDEX	WEIGHTED VALUE	PRIORITY INDEX
1	DEARBORN	GARFIELD	63.50	42.55	78	25.74	68.29
2	FAIRVIEW	GARFIELD	68.30	45.76	64	21.12	66.88
3	CONNELL	HELEN	66.80	44.76	65	21.45	66.21
4	CALIFORNIA	FOURTH	57.90	38.79	81	26.73	65.52
5	FLORENCE	EDITH	68.10	45.63	55	18.15	63.78
6	GARFIELD	NINTH	57.00	38.19	70	23.10	61.29
7	PLYMOUTH	FLORENCE	57.10	38.26	69	22.77	61.03
8	GARFIELD	TENTH	56.10	37.59	61	20.13	57.72
9	COOLEY	DICKENS	53.70	35.98	62	20.46	56.44
10	GARFIELD	FOURTH	51.00	34.17	65	21.45	55.62
11	FAIRVIEW	WASHBURN	53.10	35.58	58	19.14	54.72
12	CHESTNUT	THIRD	50.20	33.63	63	20.79	54.42
13	FRONT	PATTEE	61.50	41.21	31	10.23	51.44
14	MAIN	RYMAN	60.40	40.47	30	9.90	50.37
15	COTTONWOOD	THIRD	53.30	35.71	41	13.53	49.24
16	COTTONWOOD	SIXTH	46.80	31.36	52	17.16	48.52
17	MOUNT	CLEVELAND	53.60	35.91	38	12.54	48.45
18	JOHNSON	FOURTEENTH	62.70	42.01	18	5.94	47.95
19	STEPHENS	KENT	57.20	38.32	21	6.93	45.25
20	KENT	OXFORD	56.00	37.52	22	7.26	44.78
21	MYRTLE	FOURTH	52.90	35.44	23	7.59	43.03
22	PHILLIPS	COWPER	47.40	31.76	34	11.22	42.98
23	ARTHUR	BECKWITH	50.80	34.04	22	7.26	41.30
24	SPRUCE	McCORMICK	48.10	32.23	24	7.92	40.15
25	SCOTT	PHILLIPS	51.20	34.30	10	3.30	37.60

AVERAGE VALUES :	56.19	37.65	46.28	15.27	52.92
STANDARD DEVIATIONS :	6.12	4.10	20.99	6.93	8.96

PRIORITY INDEX = (HAZARD INDEX x 0.67) + (BENEFIT/COST INDEX x 0.33)

IMPLEMENTATION

Within Table 13, the priority lists have been arranged in a manner in which budget considerations can readily be applied in the decision to proceed with improvements. Priority ranking was the major consideration in selecting which sites will be receiving funds first. Since limited funds are available, it is usually necessary to skip over a few higher priority projects to improve a greater number of sites as soon as possible. The listing assumes that eligible project costs will be funded by MDoT Off-system Safety funds. In the past MDoT project funding limit was less than $10,000 per project period, or else formal bid letting procedures were required by MDoT. This dollar figure was used as the criteria to define construction groupings. At this time, MDoT is in the process of deciding how these project will be funded, designed and constructed in the future. In this case, it would be futile to attempt scheduling of individual projects until new policies have been set.

There is no timetable given for these improvements and it may be conceivable that MDoT could fund most of the sites in a single years period, depending on available funding. The city will want to request funding from MDoT by submitting this report to Dave Johnson, P.E., Preconstruction Engineer.

TABLE 13. PROJECT IMPLEMENTATION COST SCHEDULE

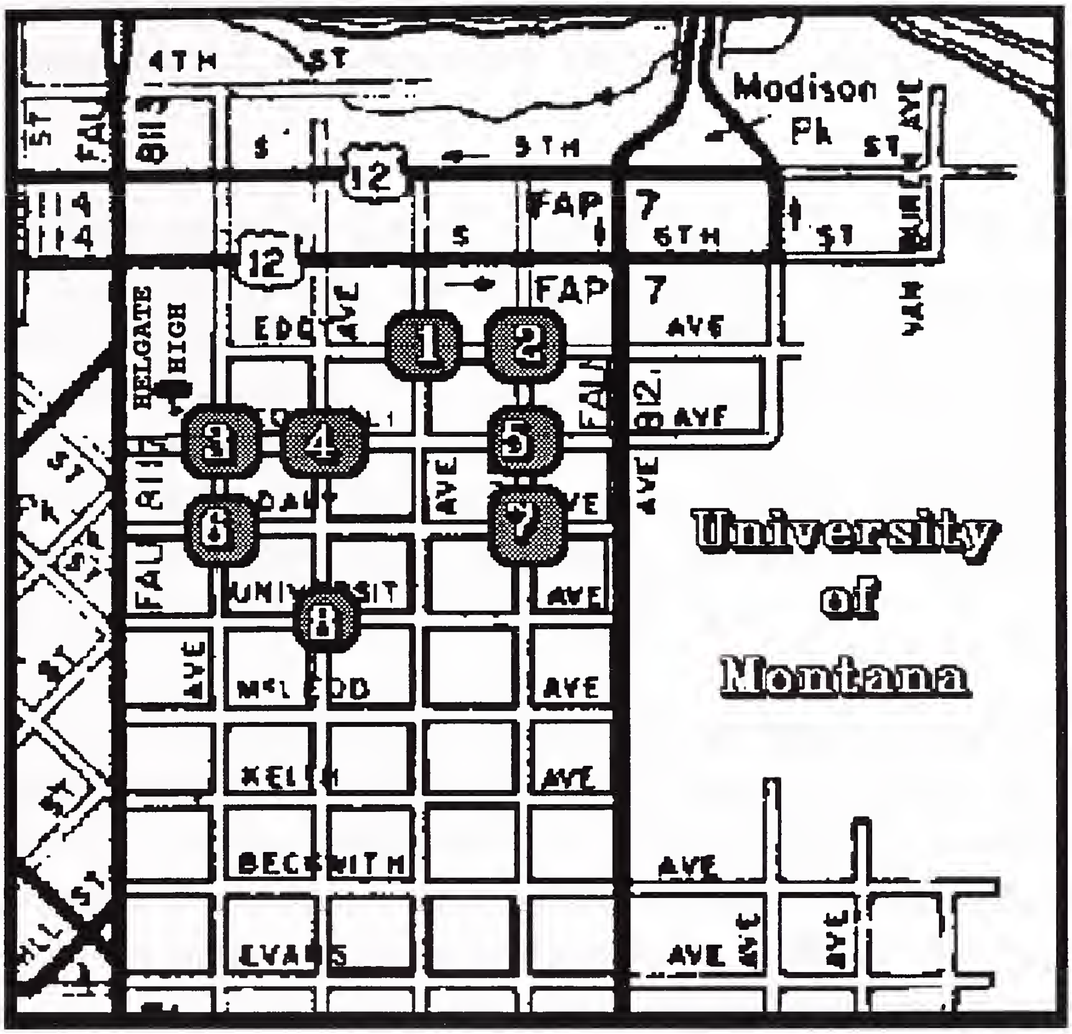
PRIORITY NO.		AVENUE	COST ESTIMATE	MDoT ELIGIBLE FUNDS	CITY FUNDS
1	DEARBORN	GARFIELD	$3,771	$3,465	$306
2	FAIRVIEW	GARFIELD	$4,920	$4,360	$560
3	CONNELL	HELEN	$815	$755	$60
4	CALIFORNIA	FOURTH	$410	$310	$100
5	FLORENCE	EDITH	$4,750	$775	$3,975
6	GARFIELD	NINTH	$595	$445	$150
7	PLYMOUTH	FLORENCE	$425	$275	$150
8	GARFIELD	TENTH	$2,010	$460	$1,550
9	COOLEY	DICKENS	$900	$660	$240
10	GARFIELD	FOURTH	$595	$445	$150
11	FAIRVIEW	WASHBURN	$1,155	$765	$390
12	CHESTNUT	THIRD	$880	$740	$140
13	FRONT	PATTEE	$8,900	$1,640	$7,260
14	MAIN	RYMAN	$10,900	$1,440	$9,460
15	COTTONWOOD	THIRD	$4,785	$3,520	$1,265
16	COTTONWOOD	SIXTH	$1,021	$931	$90
17	MOUNT	CLEVELAND	$1,590	$1,590	$0
18	JOHNSON	FOURTEENTH	$63,470	$6,150	$57,320
19	STEPHENS	KENT	$8,980	$2,310	$6,670
20	KENT	OXFORD	$7,725	$2,235	$5,490
21	MYRTLE	FOURTH	$6,670	$1,305	$5,365
22	PHILLIPS	COWPER	$1,200	$1,160	$40
23	ARTHUR	BECKWITH	$21,990	$2,990	$19,000
24	SPRUCE	McCORMICK	$7,845	$2,005	$5,840
25	SCOTT	PHILLIPS	$4,805	$3,445	$1,360
TOTAL CONSTRUCTION COSTS =			$171,107	$44,176	$126,931

STREET CORRIDORS

As previously mentioned, several street corridors have consecutive accident cluster areas which would appear to be corridor related. Elimination of these areas because of future improvement projects and other factors only left one area that could be considered as a corridor problem. A small area immediately west of the University of Montana has experienced unusually high accident rates at approximately eight intersections. The accident pattern surrounds Connell Avenue, a local east-west street, which has continuity from a University of Montana parking lot east of Arthur to Higgins, a north-south arterial.

Figure 14. illustrates the corridor area. The eight intersections and the number of accidents at each intersection is shown. The intersection of Connell and Helen is included as one of the study sites and has the highest number of accidents (10) and the highest accident rate (8.06). The average accident rate for these 8 intersections is approximately 4.8 accident per million vehicles entering (MVE). This accident rate is approximately five times the accident rate that could be expected at low volume intersections and at least twice the rate of the average for all study sites. However, the estimated traffic volumes were based on observations during the time when neither Helgate High nor the University of Montana were in session. Of the 45 total accidents 36 were angle accidents; 2 were rearend; 1 was a pedestrian; 2 were sideswipes; and 4 involved parked cars. There were 16 persons injured within the eight intersections. The accidents are clustered in the morning, noon and mid-afternoon periods, coincident with school arrivals and departures. The vast majority of accidents also occurred during mid-week.

The intersections within the corridor area are very similar in terms of street geometry and roadside culture. Traffic control devices consist mainly of parking control signs and stop signs. There is a mixture of stop controlled and uncontrolled intersection within this area. Interestingly, the only intersection on Connell Avenue which has not experienced three or more accidents in the four year reporting period was with Hilda Street and it is the only uncontrolled intersection on Connell. No specific



CORRIDOR SITE NO.	AVENUE	STREET	NUMBER OF ACCIDENTS
1	EDDY	HILDA	6
2	EDDY	HELEN	7
3	CONNELL	GERALD	3
4	CONNELL	RONALD	4
5	CONNELL	HELEN	10
6	DALY	GERALD	7
7	DALY	HELEN	5
8	UNIVERSITY	RONALD	3

TOTAL IN CORRIDOR AREA = 45

AVERAGE PER INTERSECTION = 5.6

FIGURE 14. CORRIDOR ACCIDENT NUMBERS & LOCATION

explanation for this condition can be offered, since the study observations did not occur during heavy traffic periods when the high school and university were in session.

Judging by the pattern of accident clusters; the proximity of high traffic generators on either side of this corridor; and the general layout of the street system, it is apparent that traffic filters thru this residential area to gain access to arterial and collector streets. The lack of a thru cross link in this area spreads the traffic to several east-west streets and in turn creates circulation on north-south streets to avoid congestion at the arterial street access points. Since traffic would tend to be concentrated in short time periods circulation cross traffic at the local intersections would be intense and the potential for accidents quite high.

Based on the study observations, analysis and evaluation it is clear that implementing signing and parking restrictions at every corridor intersection, such as recommended at the Connell - Helen study site, would only go so far in alleviating the existing problems in this area. Basic system changes are necessary to provide a safer and more efficient vehicular environment. Therefore, it is recommended that Connell Avenue be designated a thru street and improvements implemented to effect this change. The following improvements would be required:

1. Install stop signs on Hilda Street at its intersection with Connell Avenue and locate new signs for maximum visibility.
2. Check other existing stop signs for visibility. Trim trees and restrict parking as necessary to insure maximum approach sight distance.
3. Paint a double yellow centerline on Connell Avenue from Higgins to Arthur.
4. Restrict parking on Connell Avenue for a minimum distance of 80 feet from the curb radius on each side of each intersection approach with yellow curb paint and signing, if necessary.
5. Investigate requirements for traffic control at the intersections of Higgins and Arthur with Connell Avenue. It is probable that a left turn

bay would be required on Higgins to allow southbound left turns onto Connell without blocking traffic into the intersection of Higgins and Brooks. Depending on the peak hour level of traffic, it may be necessary to integrate a signal at Connell and Higgins with the existing signal at Brooks and Higgins or develop alternate traffic plans to effectively handle turning trafic conflicts. The intersection of Arthur and Connell would not be as difficult to control, but still may require additional traffic control devices. Both ends of Connell Avenue must allow for efficient access or the new thru street link would not serve its intended purpose.

One of the most difficult problems associated with the above recommendation will undoubtedly be loss of numerous parking spaces. It is understood that the University of Montana has had a long term problem with parking and its surrounding neighbors. Permit parking in residential neighborhoods was instituted years ago, and in some respects it has served to improve conditions. However, parking problems have not been solved entirely if one follows the continuing debates featured by local news media. The conditions evident in this corridor are a part of the overall parking problem and the solution to this corridor problem will generally worsen the overall parking problem. Resolution of this conflict will not be easy. However, it should be remembered that street traffic and on-street parking do not co-exist in harmony. For every vehicle parked along a street, safety and efficiency suffers by some magnitude that can be translated into dollars. Within this area, implementation of the recommended corridor improvements could potentially be worth $ 50,000 per year and could save pain and suffering for many people.

PROGRAM CONTINUATION

Since the basic format of the study has been outlined and an initial priority list established, continuance of this program or a similar program is strongly advised. The findings and recommendations of this study will soon become obsolete without continued updating at least on an annual basis. The following recommendations in the continuance of the program are offered to the City of Missoula:

1. The Traffic Superintendent's office should continue to receive accident reports from the Police Department.
2. One person should be assessed with the responsibility of the program to insure that all data is being supplied and processed.
3. An agreement with the City Police Department should be made which would modify computer reporting to identify cluster sites or a separate program should be used to store basic data from the police reports as they are received by the Traffic Section.
4. Criteria should be developed for the inclusion of additional sites to be analyzed, such as number of accidents, accident rate and severity.
5. Coordinate existing traffic counting programs to include areas that may not currently be covered. With broad enough coverage, estimates of volumes on all street segments can be made for screening purposes.
6. Analyze new sites according to all or selected procedures of this study and include them in the priority list when warranted.

All of the data processing and storage can be handled by most computer spreadsheet software programs. A copy of the data disk has been provided to the City of Missoula. If translation problems occur between these data files and the City's spread sheet program, they can be translated to a ASCII file, upon request.

REPORT

FIGURES

HAZARD

INDICATOR

VALUES

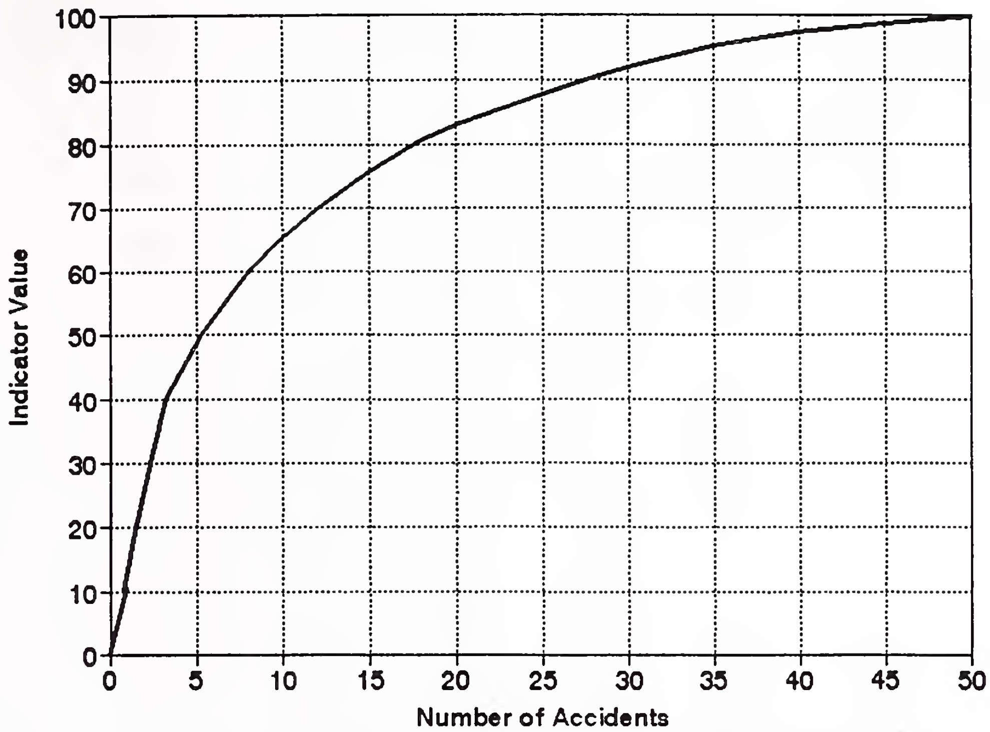


FIGURE 6. NUMBER OF ACCIDENTS INDICATOR CURVE

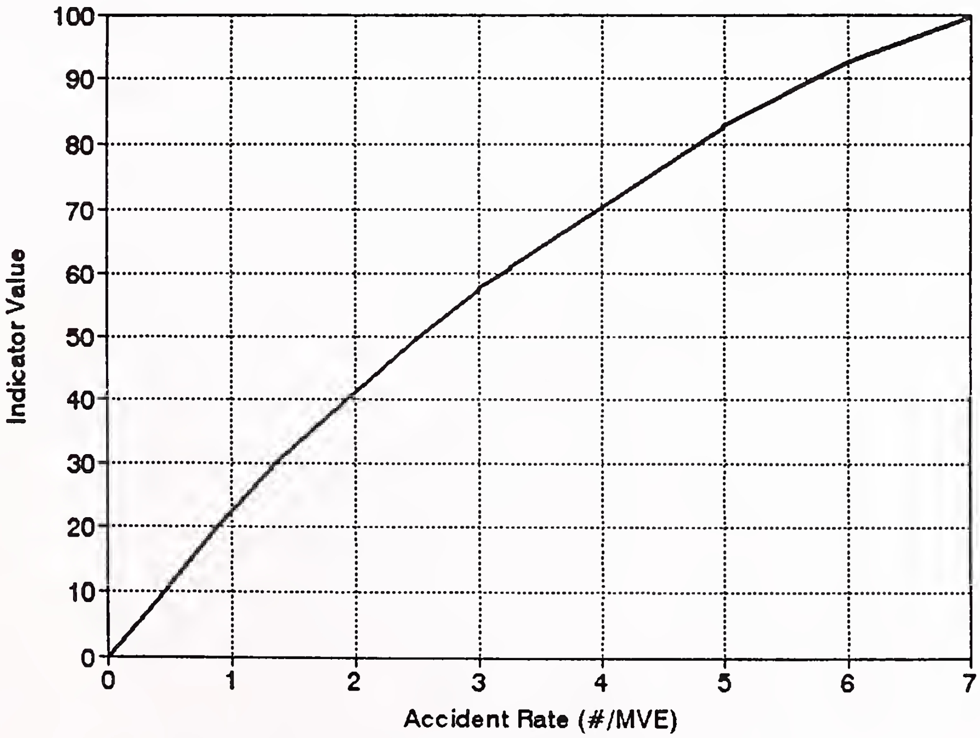


FIGURE 7. ACCIDENT RATE INDICATOR CURVE

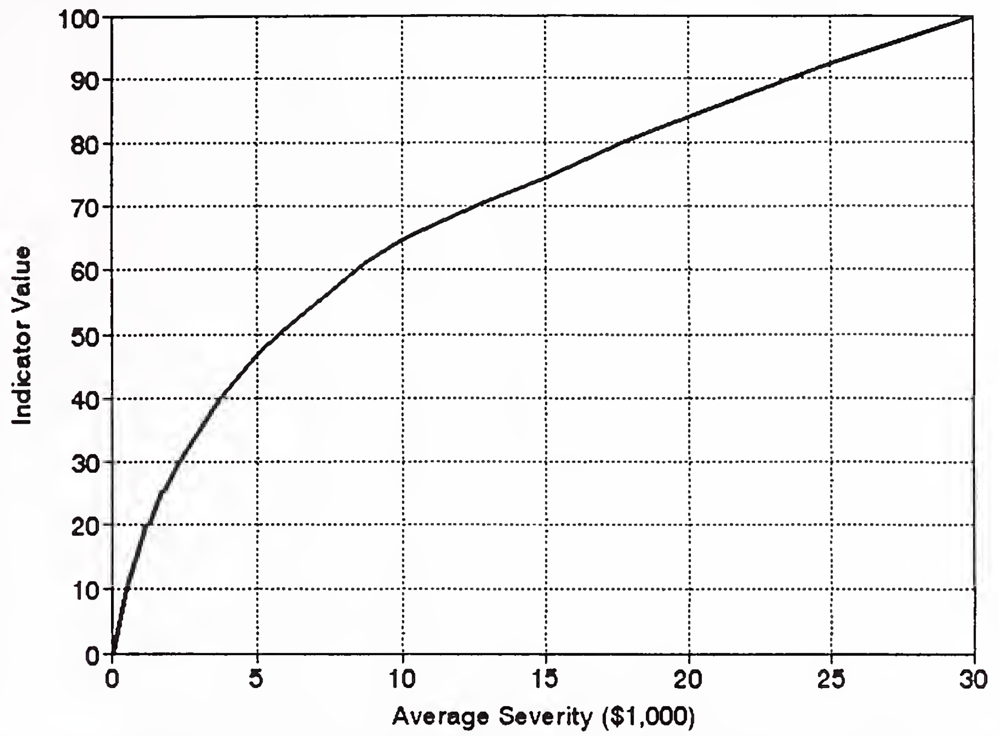


FIGURE 8. ACCIDENT SEVERITY INDICATOR CURVE

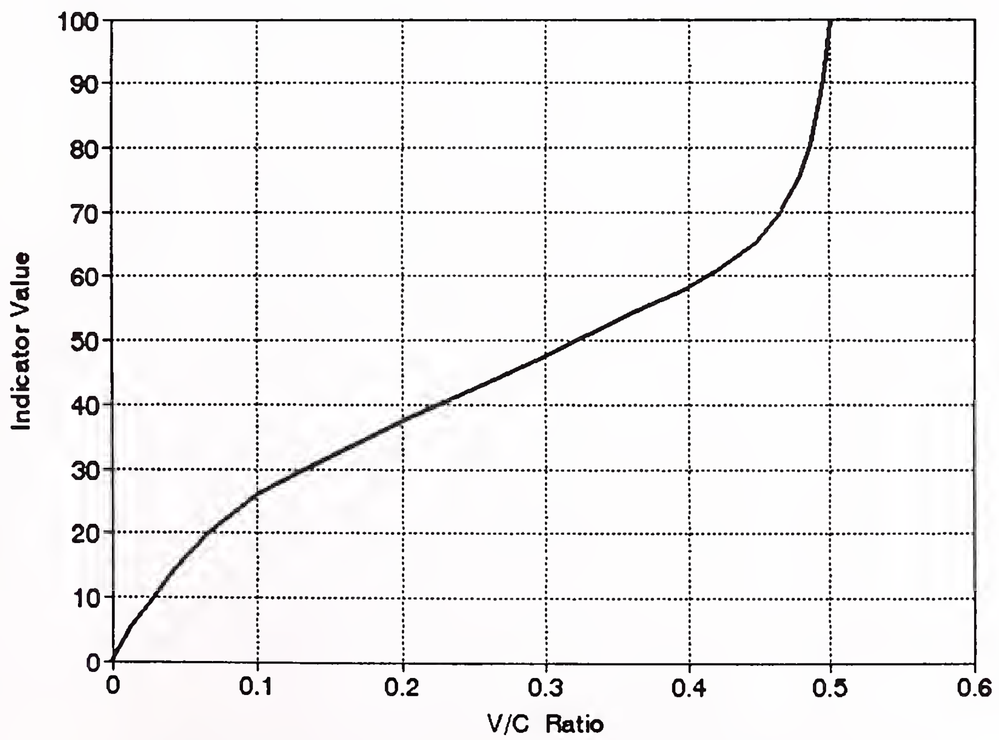


FIGURE 9. VOLUME/CAPACITY RATIO INDICATOR CURVE

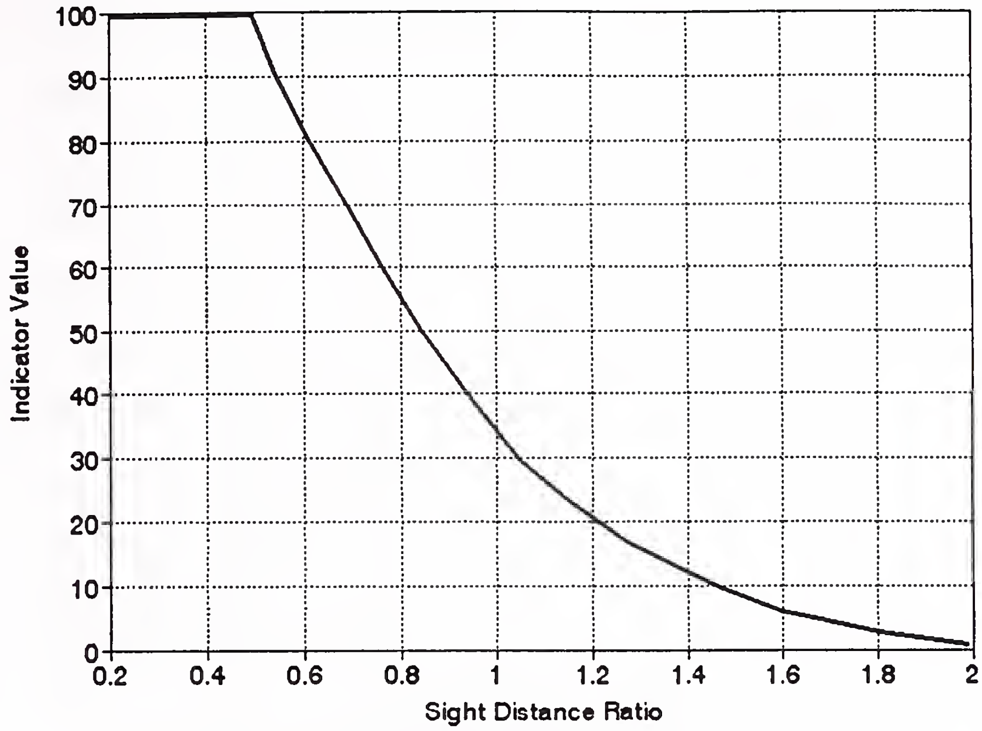


FIGURE 10. SIGHT DISTANCE RATIO INDICATOR CURVE

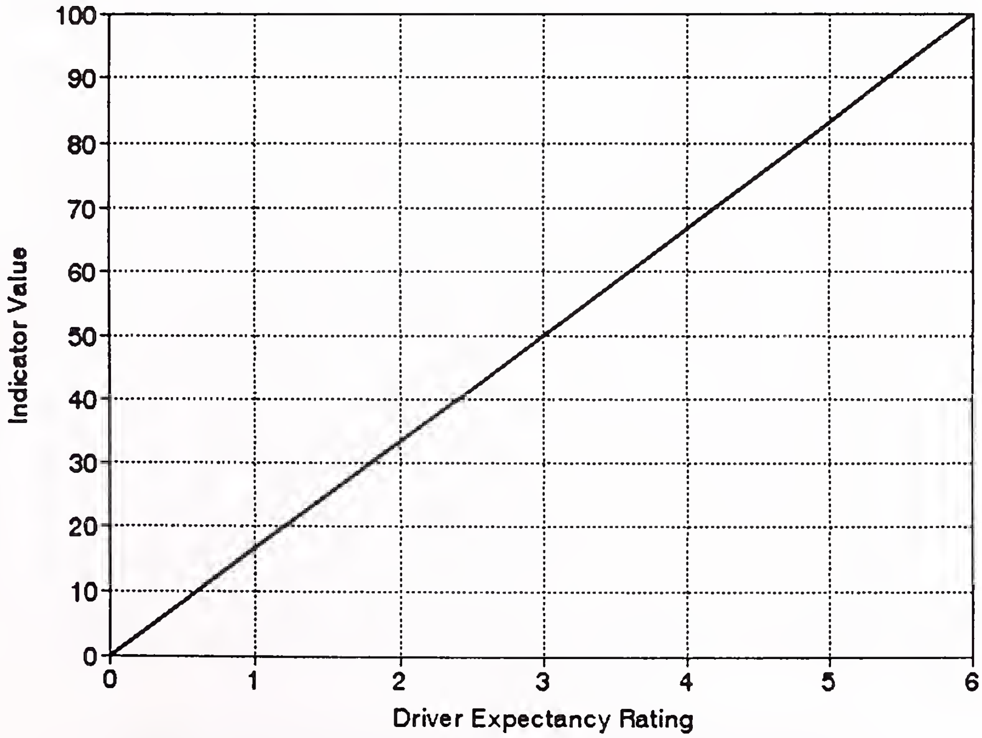


FIGURE 11. DRIVER EXPECTANCY INDICATOR CURVE

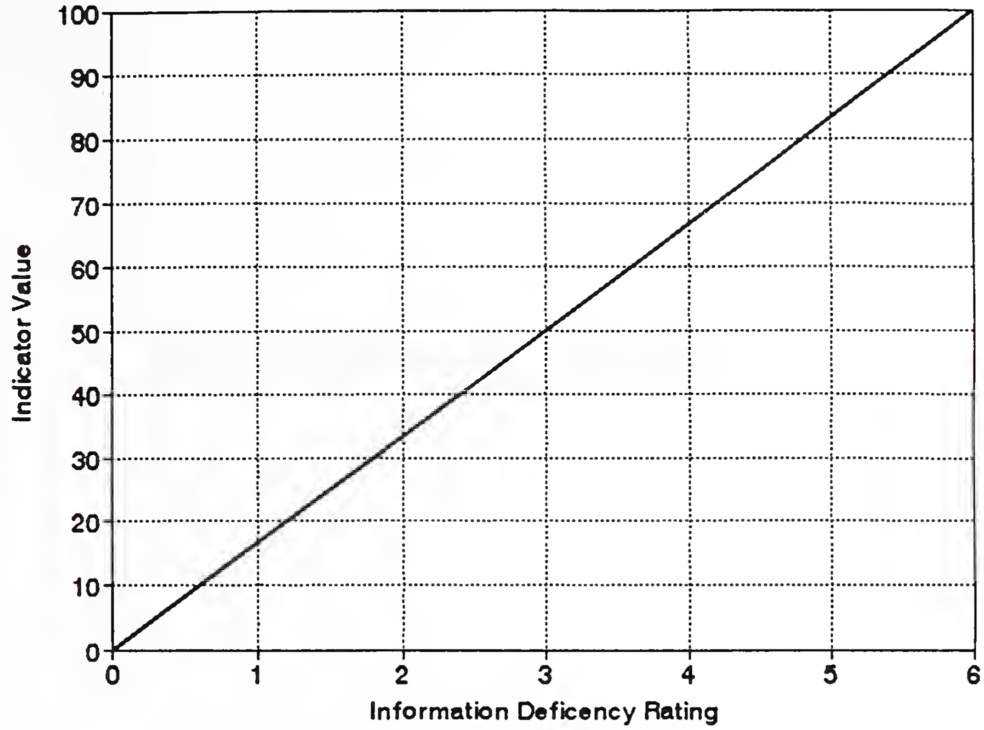


FIGURE 12. INFORMATION DEFICENCY INDICATOR CURVE

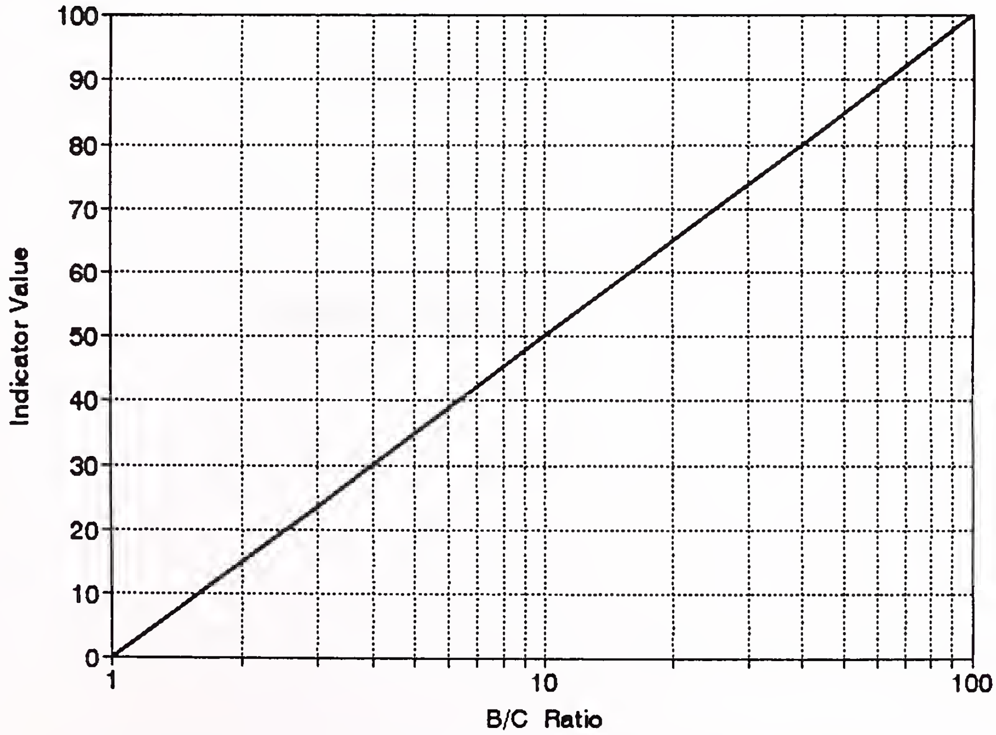


FIGURE 13. BENEFIT/COST RATIO INDICATOR CURVE

INDIVIDUAL SITES

SPECIFIC

DATA

&

ANALYSIS

SITE

NUMBER

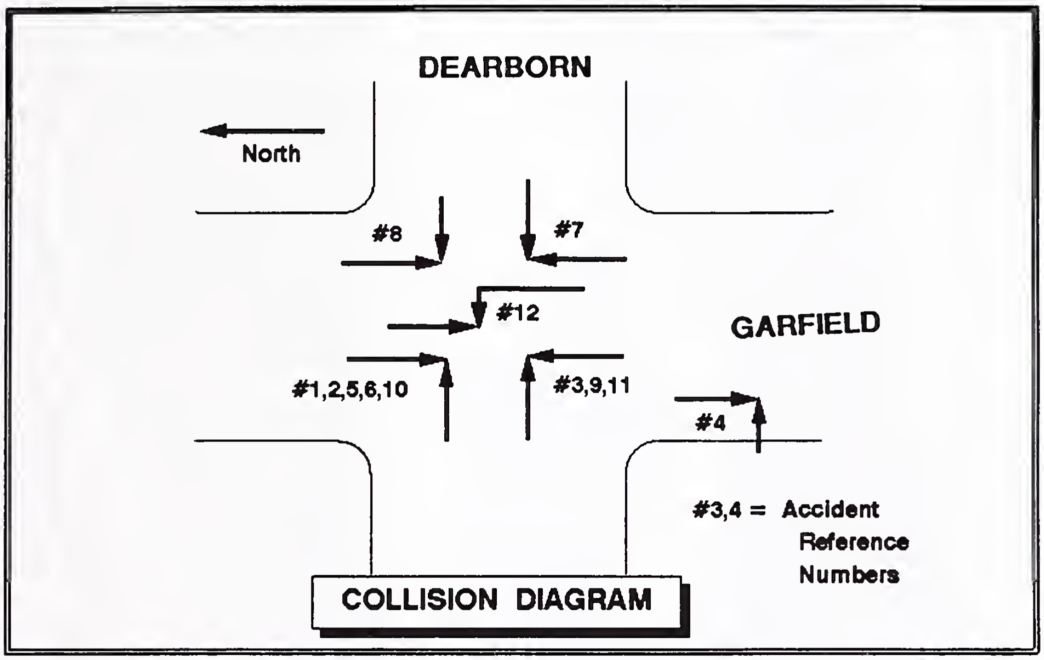
1

DEARBORN

and

GARFIELD

ACCIDENT SUMMARY
GARFIELD & DEARBORN



ACC NO.	ACCIDENT TYPE	ACCIDENT KEY							
		MO.	DAY	YEAR	TIME	SEVERITY	WEATHER	ROAD	LIGHT
1	ANGLE	3	1	88	1619	PROP DAM	SNOW	ICY	DAY
2	ANGLE	5	1	88	1423	PROP DAM	CLEAR	DRY	DAY
3	ANGLE	5	30	88	1714	INJURY	RAIN	WET	DAY
4	ANGLE	4	3	89	1455	PROP DAM	CLEAR	DRY	DAY
5	ANGLE	12	15	89	1403	PROP DAM	CLEAR	SNOW	DAY
6	ANGLE	12	24	89	1111	PROP DAM	CLEAR	ICY	DAY
7	ANGLE	1	20	90	1601	INJURY	CLEAR	WET	DAY
8	ANGLE	8	1	90	1515	PROP DAM	CLEAR	DRY	DAY
9	ANGLE	10	27	90	1603	INJURY	CLEAR	DRY	DAY
10	ANGLE	12	21	90	1138	INJURY	CLEAR	ICY	DAY
11	ANGLE	12	14	91	1723	PROP DAM	CLEAR	DRY	NITE
12	LEFT TURN	5	10	91	1329	INJURY	CLEAR	WET	DAY

ACCIDENT STATISTICS

NO. ACC.	YEAR		
3	1988	#INJ ACC	5
3	1989	#FAT ACC	0
3	1990	#PDO ACC	7
3	1991	PERSON =	12 *
12	TOTAL	NIGHTIME	8%

* No. of Persons Injured

TYPES	NUMBER	ROAD	
ANGLE	11	DRY	42%
REAR END	0	WET	25%
SIDESWIPE	0	SNOW	8%
LEFT TRN	1	ICE	25%
OTHER	0	OTHER	0%

Looking North

GARFIELD

Looking South

Looking East

DEARBORN

Looking West

TRAFFIC OPERATIONS

Dearborn is a local east-west street which runs across Missoula in segments. At its intersection with Garfield, it only has continuity for two blocks west of Brooks. Garfield is a north-south local street similar to Dearborn in that it is segmented and only has continuity for three blocks north of Brooks. The intersection of Garfield and Brooks is signalized. Garfield runs parallel to the West Gate Mall shopping center and Dearborn serves as one of several access points to the mall. A fringe loop road around the mall intersects Dearborn approximately 200 feet west of the study intersection.

Traffic volumes on the two streets are approximately equal. However at certain times during the day, Dearborn has significantly more traffic than Garfield because of the mall entrance. It was observed that 90% of the vehicles approaching the intersection on Dearborn did not entirely stop for the signs when it appeared that there were no conflicting vehicles on Garfield. This indicates that the stop does not appear to be warranted from the drivers perspective. Drivers attitudes in this respect may come from previous experience or from the local street system layout. Since most of the traffic on Dearborn is accessing the Mall and the major arterial (Brooks) is only two blocks away, the common driver mind-set would be toward an uninterrupted flow condition. The mall parking loop road west of the intersection, which forms a T-intersection with Dearborn, requires traffic on Dearborn to stop. This tends to irritate drivers and decreases their desire to make any more stops. In general, this and other similar access points are poorly designed mall entrances and it is believed that they contribute to accidents being experienced at Garfield Street intersections.

The eastbound stop sign on Dearborn is completely hidden by curbside trees planted as part of the mall landscaping and only provides 80 feet of advanced sight distance. Yellow curb only extends 20 feet west of the subject stop sign. Parked vehicles on Dearborn may further restrict sight distance. Parking on Garfield at certain times of the day also creates sight distance obstructions for vehicles entering from Dearborn. Since parking on Garfield has a high turnover rate, these restrictions are intermittent.

All but one of the 12 accidents at this intersection were angle accidents. Only three of the angle accidents involved vehicles who had stopped at the sign before entering.

IMPROVEMENTS

Initial observations of this intersection would indicate that the stop control should probably be relocated to Garfield rather than Dearborn. However, average daily traffic on the approach legs would not entirely support this action. Also, turning movements and relative vehicle trip lengths on respective approaches indicate that reversing the direction of stop control may only change the direction and type of accident.

Since a large part of the problem at this intersection is the visibility of stop signs, the primary improvement must be trimming of trees obstructing vision and replacing existing signs with new 36" stop signs. In order to visually reinforce the stop condition, stop bars and centerlines should be added to the Dearborn approaches. Any revisions implemented on the mall side of the intersection must be completed with full cooperation from the mall owners since the mall side of the intersection is on private property.

Because of heavy turning movements at the adjacent intersection on Garfield at Fairview, it was deemed necessary to provide left turn bays to provide vehicle refuge and to avoid conflicts created when a stoped left turning vehicle is passed on the right by a thru vehicle and the side street driver cannot see this maneuver. This left turn bay should be extended to the intersection with Dearborn by providing a continuous two way left turn lane. This will accomplish two things: it will allow removal of parking on Garfield, which currently causes critical sight restrictions and it will provide refuge area for vehicles turning into the mid-block approaches. Centerline markings should also be extended north to the intersection of Dearborn and South Avenue. These changes will create vast visual changes at this intersection which are expected to greatly reduce accident potential due to the revised traffic operations.

Long Term Improvements - should consider modification to the mall entrances as a primary goal. Removal of the T-intersection at the loop road and provisions for an extended roadway into the mall parking area will reduce on-site accident potential and improve driver expectancy at the Garfield intersections. However, if entrances conditions are modified, it may be necessary to reverse the stop condition at both the Dearborn and Fairview intersections with Garfield. A proposed future overpass at Brooks and South Ave. will also change traffic patterns at this site location.

DEARBORN & GARFIELD

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	2900
SOUTH APP	3100
EAST APP	3700
WEST APP	3000

EXISTING CONTROL:

NONE	
YIELD	
STOP	YES
SIGNAL	

RECOMMENDED CONTROL:

PARKING	YES
YEILD	
STOP	YES
SIGNAL	
MARKING	YES
GUIDANCE	
REGULATORY	YES

ESTIMATED COST:

TOTAL	$3771
MDoT FUND	$3465
CITY FUND	$306

% ACCIDENT REDUCTION:

	NUMBER	PERCENT
INJ/FTL	3.1	70%
PDO	4.2	60%

BENEFIT/COST RATIO: 37

	INDEX VALUE	SITE RANK
# ACCIDENTS	72	4
ACCIDENT RATE	32	11
SEVERITY	70	1
VOL/CAPACITY	75	8
SIGHT DIST.	100	3
DRIVER EXPECT	75	10
INFO DEFICIENT	58	16
HAZARD INDEX	63.5	4
B/C RATIO	78	2

PRIORITY	68.3	1

SITE

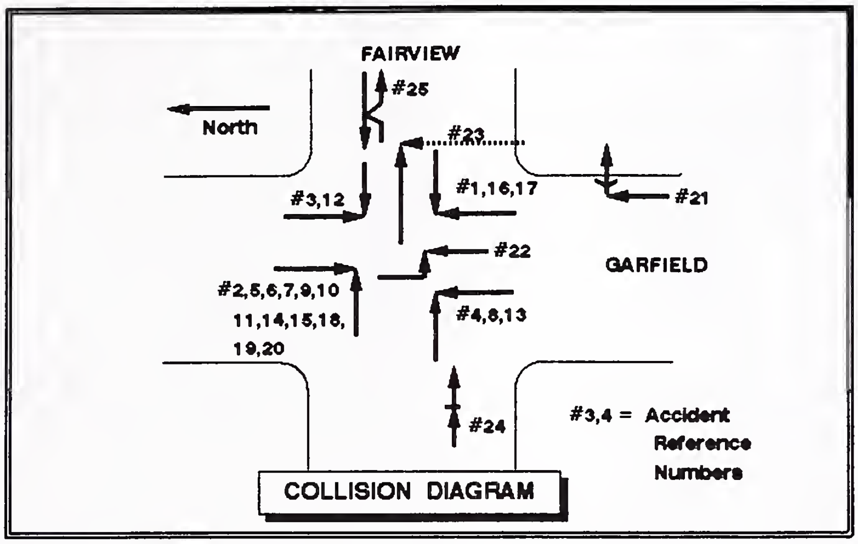
NUMBER

2

GARFIELD

and
FAIRVIEW

ACCIDENT SUMMARY
FAIRVIEW & GARFIELD



ACCIDENT KEY

ACC NO.	ACCIDENT TYPE	MO.	DAY	YEAR	TIME	SEVERITY	WEATHER	ROAD	LIGHT
1	ANGLE	1	4	88	1529	PROP DAM	CLEAR	ICY	DAY
2	ANGLE	1	21	88	1621	PROP DAM	CLEAR	SNOW	DAY
3	ANGLE	2	25	88	1459	PROP DAM	CLEAR	DRY	DAY
4	ANGLE	6	19	88	1602	PROP DAM	CLEAR	DRY	DAY
5	ANGLE	9	4	88	1306	PROP DAM	CLEAR	DRY	DAY
6	ANGLE	12	19	88	1424	PROP DAM	SNOW	ICY	DAY
7	ANGLE	12	24	89	1434	INJURY	CLEAR	DRY	DAY
6	ANGLE	1	24	90	1600	PROP DAM	CLEAR	DRY	DAY
9	ANGLE	2	3	90	1606	PROP DAM	CLEAR	DRY	DAY
10	ANGLE	5	10	90	1216	INJURY	CLEAR	DRY	DAY
11	ANGLE	6	14	90	1241	INJURY	CLEAR	DRY	DAY
12	ANGLE	9	4	90	1136	PROP DAM	CLEAR	DRY	DAY
13	ANGLE	10	2	90	1152	PROP DAM	CLEAR	DRY	DAY
14	ANGLE	10	5	90	1834	INJURY	CLEAR	DRY	DAY
15	ANGLE	12	31	90	1359	PROP DAM	CLEAR	ICY	DAY
16	ANGLE	2	13	91	1315	PROP DAM	CLEAR	DRY	DAY
17	ANGLE	3	2	91	1119	PROP DAM	SNOW	ICY	DAY
16	ANGLE	5	7	91	1608	PROP DAM	CLEAR	WET	DAY
19	ANGLE	6	25	91	1647	PROP DAM	CLEAR	DRY	DAY
20	ANGLE	9	25	91	1522	PROP DAM	CLEAR	DRY	DAY
21	BACKING	6	6	90	1456	PROP DAM	CLEAR	DRY	DAY
22	LEFT TURN	12	31	91	1971	PROP DAM	CLEAR	DRY	NITE
23	PEDESTRIAN	9	3	91	631	INJURY	CLEAR	DRY	DAY
24	REAREND	4	15	89	1544	PROP DAM	CLEAR	DRY	DAY
25	SIDE SWIPE	12	16	90	1350	PROP DAM	SNOW	ICY	DAY

ACCIDENT STATISTICS

NO. ACC.	YEAR		
6	1988	#INJ ACC	6
2	1989	#FAT ACC	0
10	1990	#PDO ACC	19
7	1991	PERSON =	7 *
25	TOTAL	NIGHTIME	0%

TYPES	NUMBER	ROAD	
ANGLE	20	DRY	72%
REAR END	1	WET	4%
SIDESWIPE	1	SNOW	4%
LEFT TRN	1	ICE	20%
OTHER	2	OTHER	0%

*** No. of Persons Injured**

Looking North

GARFIELD

Looking South

Looking East

FAIRVIEW

Looking West

TRAFFIC OPERATIONS

This intersection is directly south of the Garfield - Dearborn intersection described in site section #1. Fairview is similar to Dearborn in that it is a segmented east-west local street. It only has continuity for 1 block west of Brooks before it intersects Garfield at the entrance to the West Gate Mall. The intersection of Fairview and Brooks is signalized. Fairview intersects the mall loop road at a T-intersection, similar to Dearborn.

Traffic operations at this intersection are similar to the Dearborn intersection except that turning movement volumes are significantly greater. Drivers on Fairview are also reluctant to stop at this intersection, but there are more conflicts due to higher percentages of turning movements. Parked cars along Garfield obstruct sight distance from the stopped vehicle position. This fact, along with the aggressive nature of drivers which are reluctant to stop anyway, results in vehicles entering Garfield without adequate gaps in traffic. There were at least five potential right angle collisions observed in a one hour peak traffic period. Vehicles on Garfield appear to be equally tenacious about their right to proceed unimpeded, since no tail lights were evident during these near collisions. One of the reasons Garfield drivers are reluctant to slow or stop is due to the fact that the majority of vehicles are using Garfield as a link between Brooks and South Avenue. The intersection of Brooks and South Avenue, located approximately 3 blocks northeast of the Brooks - Garfield intersection, prohibits northbound left turns and eastbound right turns. Thus, Garfield essentially serves as extended turn lanes between the two major arterials.

Like the Dearborn intersection, traffic volumes on the two streets are approximately equal. However at certain times during the day, Fairview has significantly more traffic than Garfield because of the mall entrance. The eastbound stop sign on Fairview is partially hidden by curbside trees planted as part of the mall landscaping. Yellow curb only extends 20 feet west of the subject stop sign and parked vehicles on Fairview may further restrict sight distance. The westbound approach has a left turn bay marked. Markings on the eastbound leg line up with the middle of the left turn lane. Vehicles turning left from the westbound bay block the line of vision for vehicles proceeding thru in the adjacent lane and create potential conflicts. In addition, left turning vehicles on Garfield wait in the middle of the street for an

opposing traffic gap and thru traffic on Garfield passes them on the right. This presents a danger to right turning Fairview traffic when drivers believe that the left turning vehicle has blocked the conflicting traffic movement.

Businesses on the east side on the intersection add to operational problems at the intersection. A body shop in the southeast corner has approaches close to the intersection and there are vehicles backing into traffic continuously. These businesses also have high parking demand and vehicles and constantly parked behind the curb in the clear vision area.

All but five of the 25 accidents at this intersection were angle accidents. Only five of the angle accidents definitely involved vehicles who had stopped at the signs before entering.

IMPROVEMENTS

Initial observations of this intersection also indicate that the stop control should probably be relocated to Garfield rather than Fairview, but as with the Dearborn intersection existing traffic conditions would not entirely support this action.

Visibility of the stop signs must be considered a primary consideration by trimming of trees obstructing vision and replacing the existing 30" sign with new 36" stop signs and relocating the existing 48" sign for the eastbound approach. In order to visually reinforce the stop condition, a stop bar should be added to the westbound approach. Any improvements completed on the mall side of the intersection will have to be coordinated with the mall owners, since it is private property.

Because of heavy turning movements at this intersection, it is recommended that left turn bays be implemented on Garfield. This will provide vehicle refuge and avoid conflicts created when a stoped left turning vehicle is passed on the right by a thru vehicle and the side street driver cannot see this maneuver. Since this problem includes adjacent approaches and intersections, the left turn bay should be extended to provide a continuous two way left turn lane. This will accomplish two things: it will allow removal of parking on Garfield, which currently causes critical sight restrictions and it will provide refuge area for vehicles turning into the mid-block approaches.

The westbound left turn bay on Fairview serves to limit sight distance for the major thru movement. Less potential conflict would be realized if the left turn bay were converted to left & thru movements and the outside lane could then become a right turn lane. This will also allow better defined and more restrictive west bound approach markings, which will help prevent erratic movements on that approach.

Long Term Improvements - should consider modification to the mall entrances as a primary goal. Removal of the T-intersection at the loop road and provisions for an extended roadway into the mall parking area will reduce on-site accident potential and improve driver expectancy at the Garfield intersections. However, if entrances conditions are modified, it may be necessary to reverse the stop condition at both the Dearborn and Fairview intersections with Garfield.

As with site #1, implementation of a future overpass at the intersection of Brooks and South Avenue will dramatically change vehicle travel patterns in this area. Future project planning for the interchange should address the impacts on related system streets such as Garfield.

FAIRVIEW & GARFIELD

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	3100
SOUTH APP	3200
EAST APP	3700
WEST APP	2800

EXISTING CONTROL:

NONE	
YIELD	
STOP	YES
SIGNAL	

RECOMMENDED CONTROL:

PARKING	YES
YEILD	
STOP	YES
SIGNAL	
MARKING	YES
GUIDANCE	
REGULATORY	YES

ESTIMATED COST:

TOTAL	$4,920
MDoT FUND	$4,360
CITY FUND	$560

% ACCIDENT REDUCTION:

	NUMBER	PERCENT
INJ/FTL	2.8	56%
PDO	12.4	62%

BENEFIT/COST RATIO: 19

	INDEX VALUE	SITE RANK
# ACCIDENTS	91	1
ACCIDENT RATE	57	8
SEVERITY	48	15
VOL/CAPACITY	78	7
SIGHT DIST.	100	8
DRIVER EXPECT	75	9
INFO DEFICIENT	58	18
HAZARD INDEX	68.3	1
B/C RATIO	64	7

PRIORITY	66.9	2

SITE

NUMBER

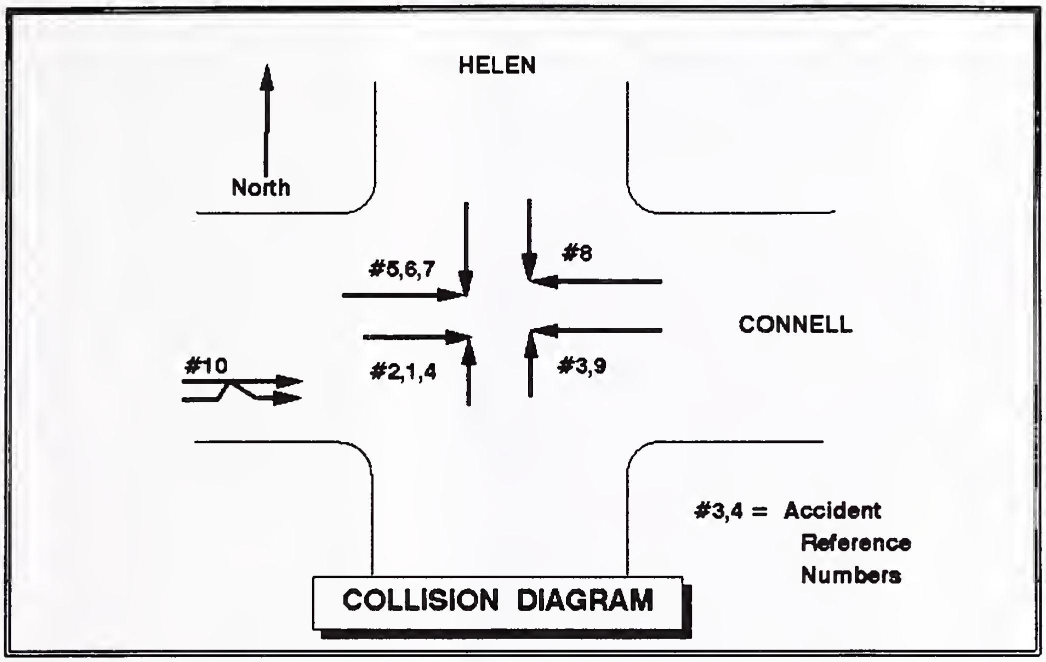
3

CONNELL

and

HELEN

ACCIDENT SUMMARY
CONNELL & HELEN



ACCIDENT KEY

ACC NO.	ACCIDENT TYPE	MO.	DAY	YEAR	TIME	SEVERITY	WEATHER	ROAD	LIGHT
1	ANGLE	1	25	89	1741	PROP DAM	CLEAR	WET	NITE
2	ANGLE	2	8	90	826	INJURY	CLEAR	ICY	DAY
3	ANGLE	5	24	90	1200	INJURY	CLEAR	WET	DAY
4	ANGLE	10	29	90	852	PROP DAM	CLEAR	DRY	DAY
5	ANGLE	12	6	90	1316	PROP DAM	CLEAR	DRY	DAY
6	ANGLE	1	15	91	742	PROP DAM	CLEAR	ICY	DAY
7	ANGLE	2	7	91	1506	PROP DAM	CLEAR	WET	DAY
8	ANGLE	4	4	91	1112	PROP DAM	CLEAR	DRY	DAY
9	ANGLE	9	10	91	1125	PROP DAM	CLEAR	DRY	DAY
10	SIDE SWIPE	4	1	88	1036	PROP DAM	CLEAR	DRY	DAY

ACCIDENT STATISTICS

NO. ACC.	YEAR			
1	1988	#INJ ACC	2	
1	1989	#FAT ACC	0	
4	1990	#PDO ACC	8	
4	1991	PERSON =	2	*
10	TOTAL	NIGHTIME	10%	

TYPES	NUMBER	ROAD	
ANGLE	9	DRY	50%
REAR END	0	WET	30%
SIDESWIPE	1	SNOW	0%
LEFT TRN	0	ICE	20%
OTHER	0	OTHER	0%

*** No. of Persons Injured**


Looking North

HELEN


Looking South


Looking East

CONNELL


Looking West From Helen

TRAFFIC OPERATIONS

Connell is a local east-west street and Helen is a local north-south street. Their intersection is located one block west of Arthur Street which is on the western fringe of the University of Montana. This intersection is one of several intersections in the area which constitutes a corridor described in the main body of this report. The primary operational problem noted at this intersection involves sight distance obstructions involving trees and parking. Sight distance to the stop signs on Helen is not impede by trees, however large tree trunks along Connell provide partial sight obstructions at various angles. Parking along Connell does impede sight distance, especially when campers and other tall vehicles are parked. This intersection appears to be typical of all other intersections in the general area, except that some of the intersections are not stop controlled.

Unfortunately, timing of this study did not allow for observations of traffic movements when the university and the high school (four blocks west of the site) were in session. All of the accidents occurred on weekdays during morning, noon and mid-afternoon periods. Accident occurrence coincides with peak school arrivals and departures. Nine of the ten accidents were angle accidents occurring in all quadrants of the intersection. All but one of the accidents involved failure to stop at the signs.

IMPROVEMENTS

From accident history and assumed operational characteristics during peak periods of the year, it is felt that over sized stop signs on the Helen approaches would place additional emphasis on the stop condition. In addition, parking restrictions, which would allow for safe vehicular crossing of Connell, would be required. The proposed parking restrictions were calculated using a dynamic vehicle model and liberal vehicle positioning to define the clear vision zone. Parking restrictions would also avoid congestive clutter at this intersection during peak traffic periods and reduce the amount of information that drivers have to deal with.

Long term improvements at this intersection would be dependent upon corridor improvements in this area. If Connell is established as a thru street, additional pavement markings on the side street may be necessary to further emphasize the stop condition and importance of the thru street designation.

CONNELL & HELEN

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	500
SOUTH APP	400
EAST APP	400
WEST APP	400

EXISTING CONTROL:

NONE	
YIELD	
STOP	YES
SIGNAL	

RECOMMENDED CONTROL:

PARKING	YES
YEILD	
STOP	YES
SIGNAL	
MARKING	
GUIDANCE	
REGULATORY	

ESTIMATED COST:

TOTAL	$815
MDoT FUND	$755
CITY FUND	$60

% ACCIDENT REDUCTION:

	NUMBER	PERCENT
INJ/FTL	1.0	50%
PDO	3.5	44%

BENEFIT/COST RATIO: 20

	INDEX VALUE	SITE RANK
# ACCIDENTS	67	7
ACCIDENT RATE	100	1
SEVERITY	44	18
VOL/CAPACITY	14	19
SIGHT DIST.	100	12
DRIVER EXPECT	67	14
INFO DEFICIENT	58	13
HAZARD INDEX	66.8	3
B/C RATIO	65	5

PRIORITY	66.2	3

SITE

NUMBER

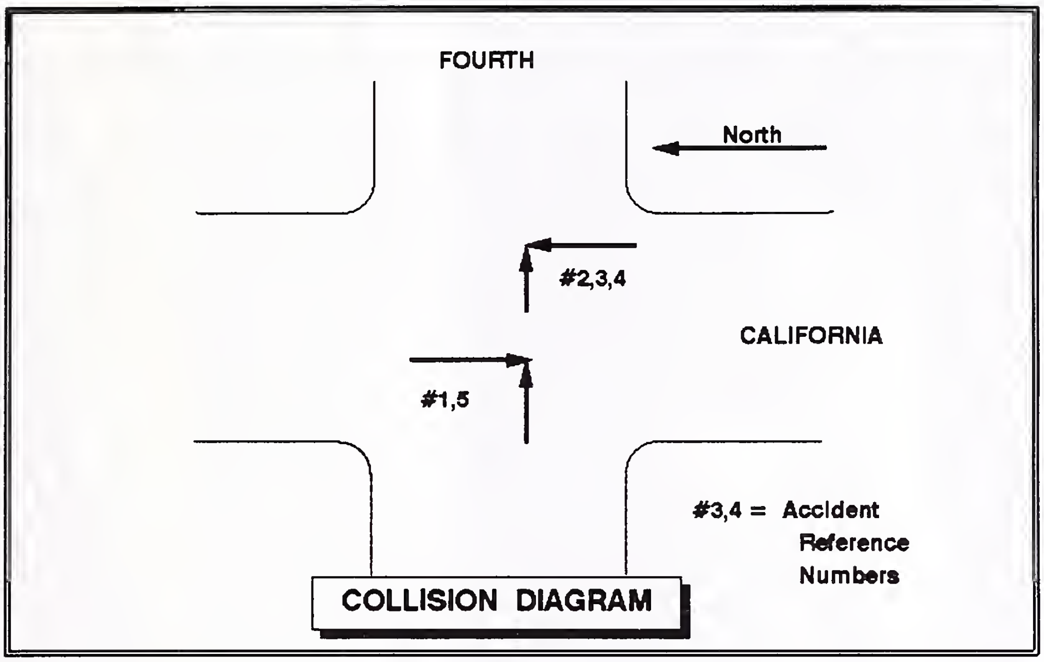
4

CALIFORNIA

and

FOURTH

ACCIDENT SUMMARY
CALIFORNIA & FOURTH



COLLISION DIAGRAM

ACC NO.	ACCIDENT TYPE	ACCIDENT KEY MO.	DAY	YEAR	TIME	SEVERITY	WEATHER	ROAD	LIGHT
1	ANGLE	9	27	88	1646	INJURY	CLEAR	DRY	DAY
2	ANGLE	6	29	89	1318	PROP DAM	CLEAR	DRY	DAY
3	ANGLE	12	17	90	1506	INJURY	CLEAR	ICY	DAY
4	ANGLE	2	5	91	1558	PROP DAM	CLEAR	SNOW	DAY
5	ANGLE	7	26	91	1141	PROP DAM	CLEAR	DRY	DAY

ACCIDENT STATISTICS

NO. ACC.	YEAR		
1	1988	#INJ ACC	2
1	1989	#FAT ACC	0
1	1990	#PDO ACC	3
2	1991	PERSON =	2 *
5	TOTAL	NIGHTIME	0%

* No. of Persons Injured

TYPES	NUMBER	ROAD	
ANGLE	5	DRY	60%
REAR END	0	WET	0%
SIDESWIPE	0	SNOW	20%
LEFT TRN	0	ICE	20%
OTHER	0	OTHER	0%


Looking North


Looking South

CALIFORNIA


Looking East


Looking West

FOURTH

TRAFFIC OPERATIONS

California and Fourth are both local streets. Fourth runs in an east-west direction and is continuous for 24 city blocks. California runs north-south and has continuity for eight city blocks. All approach legs to this intersection have low traffic volumes. Both of the adjacent intersections on California have stop signs. View of the intersection area is open and apparent from all approach legs. A stone wall with a fence and trees are located in the southeast corner of the intersection and constitutes a permanent intrusion into the required sight triangle for uncontrolled intersections. A tree on the north side of Fourth, west of the intersection, has branches hanging down to the ground. Overgrown tree branches actually occupy an entire parking space along the curbed street. The vision obstruction created by this tree is on the fringe of the site triangle, but never the less, it creates an imposing obstacle. All five accidents at this intersection were angle accidents. None of the accidents occurred in the southeast corner where the permanent sight restriction exists. Accident patterns would suggest that the "Misdirected Attention Syndrome" was at work. At any intersection where an obvious sight obstacle is present, most drivers will devote 90% of their cognitive abilities to seeing past the obstacle. The remaining 10% is devoted to controlling the vehicle rather than checking for conflicting traffic in the other direction.

IMPROVEMENTS

Since permanent sight restrictions prevent drivers from approaching the intersection without full knowledge of potential conflicts, stop control is required. Stop signs should be located on California, since adjacent intersections are already controlled by stop signs and better control of curb side parking could be achieved. Curbs within the intersection area should also be painted yellow to insure minimum sight restriction from parked vehicles. the overgrown tree on the northwest side should be trimmed to a minimum of 8 feet above the ground.

Long term recommendation are not considered applicable to this site.

CALIFORNIA & FOURTH

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	300
SOUTH APP	300
EAST APP	300
WEST APP	300

EXISTING CONTROL:

NONE	
YIELD	
STOP	
SIGNAL	

RECOMMENDED CONTROL:

PARKING	YES
YEILD	
STOP	YES
SIGNAL	
MARKING	
GUIDANCE	
REGULATORY	

ESTIMATED COST:

TOTAL	$410
MDoT FUND	$310
CITY FUND	$100

% ACCIDENT REDUCTION:

	NUMBER	PERCENT
INJ/FTL	1.2	60%
PDO	1.8	60%

BENEFIT/COST RATIO: 42

	INDEX VALUE	SITE RANK
# ACCIDENTS	50	18
ACCIDENT RATE	89	5
SEVERITY	51	9
VOL/CAPACITY	10	22
SIGHT DIST.	55	19
DRIVER EXPECT	58	20
INFO DEFICIENT	58	14
HAZARD INDEX	57.9	9
B/C RATIO	81	1

PRIORITY	65.5	4

SITE

NUMBER

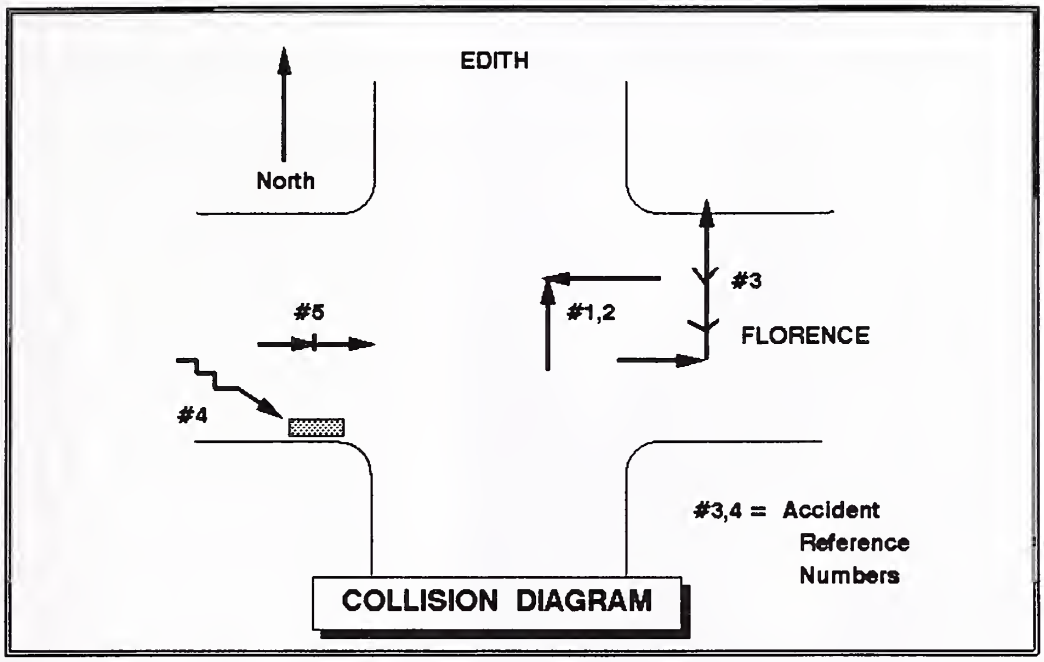
5

FLORENCE

and

EDITH

ACCIDENT SUMMARY
FLORENCE & EDITH



ACC NO.	ACCIDENT TYPE	MO.	DAY	YEAR	TIME	SEVERITY	WEATHER	ROAD	LIGHT
		ACCIDENT KEY							
1	ANGLE	9	23	88	1553	INJURY	CLEAR	DRY	DAY
2	ANGLE	10	13	89	1117	INJURY	CLEAR	DRY	DAY
3	BACKING	9	20	91	1150	PROP DAM	CLEAR	DRY	DAY
4	PARKED VEH	8	23	88	703	PROP DAM	CLEAR	DRY	NITE
5	REAREND	5	21	90	805	PROP DAM	CLEAR	DRY	DAY

ACCIDENT STATISTICS

NO. ACC.	YEAR		
2	1988	#INJ ACC	2
1	1989	#FAT ACC	0
1	1990	#PDO ACC	3
1	1991	PERSON =	3 *
5	TOTAL	NIGHTIME	20%

*** No. of Persons Injured**

TYPES	NUMBER	ROAD	
ANGLE	2	DRY	100%
REAR END	1	WET	0%
SIDESWIPE	0	SNOW	0%
LEFT TRN	0	ICE	0%
OTHER	2	OTHER	0%

Looking North

Looking South

EDITH

Looking East

Looking West

FLORENCE

TRAFFIC OPERATIONS

Florence and Edith are both local streets within an area of town where the grid patterns parallels US 93 (Brooks). Florence runs in a northwest by southeast direction while Edith runs in a northeast by southwest direction. For the purposes of discussion all references to Edith will be in a north-south direction. The intersection is located one block south of Stephens and two blocks north of Brooks, which are two arterial streets. Loyola High School is located in the northeast corner of the intersection. The most distinctive conditions with regard to this intersection is the disparity in street widths. Streets surrounding the high school are much wider on the school side to accommodate parking. When school is not in session, the wider streets misrepresent required driver behavior and violates expectation. Unfortunately, traffic operations were not observed when school was in session. However, it is assumed that the streets are full of parked vehicles and pedestrian activity exists.

Accidents at this intersection are mixed. Two angle accidents indicates a problem with sight distance due to a wood fence in the southeast corner. A rearend accident was related to side street traffic and a pedestrian. A backing accident and a parked car accident were both related to lack of parking control in the intersection area.

IMPROVEMENTS

Since permanent sight restrictions prevent drivers from approaching the intersection without full knowledge of potential conflicts, stop control is required. Stop signs should be located on Edith, since adjacent intersections are already controlled by stop signs and it is anticipated that the major flow of traffic during peak school periods would favor Florence.

Uncontrolled parking must be restricted in the intersection area. Present street geometry requires that new curbs be installed within an appropriate area of the northeast corner to better define vehicle paths through the intersection and to provide proper sight distance. Areas behind the new curb should be landscaped in a manner which would discourage pedestrian from crossing at any point except the corners. Ladder type cross walks would have to be moved to match the new curb sections and the existing ped x-ing signs in the

southeast corner can be moved to the northeast corner. Centerlines and stop bars are considered essential to reinforce the stop condition. Implementation of this alternative should include planning and participation by Loyola High School officials. Whatever additional improvements may be considered at this location, none should be considered which would erode the integrity of traffic control at the intersection.

Long Term Improvements - should consider general construction of a street section separate from parking within an area surrounding the high school. The capital intensive nature of this type improvement may be too much for either the high school or the city to accomplish, but a joint effort would provide benefits to all concerned.

FLORENCE & EDITH

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	300
SOUTH APP	300
EAST APP	200
WEST APP	250

EXISTING CONTROL:

NONE	
YIELD	
STOP	
SIGNAL	

RECOMMENDED CONTROL:

PARKING	YES
YEILD	
STOP	YES
CURB/WALK	YES
MARKING	YES
WARNING	YES
REGULATORY	

ESTIMATED COST:

TOTAL	$4750
MDoT FUND	$775
CITY FUND	$3975

% ACCIDENT REDUCTION:

	NUMBER	PERCENT
INJ/FTL	1.4	70%
PDO	1.0	33%

BENEFIT/COST RATIO: 13

	INDEX VALUE	SITE RANK
# ACCIDENTS	50	21
ACCIDENT RATE	96	3
SEVERITY	58	2
VOL/CAPACITY	9	23
SIGHT DIST.	39	23
DRIVER EXPECT	96	1
INFO DEFICIENT	83	2
HAZARD INDEX	68.1	2
B/C RATIO	55	2

PRIORITY	63.8	5

SITE

NUMBER

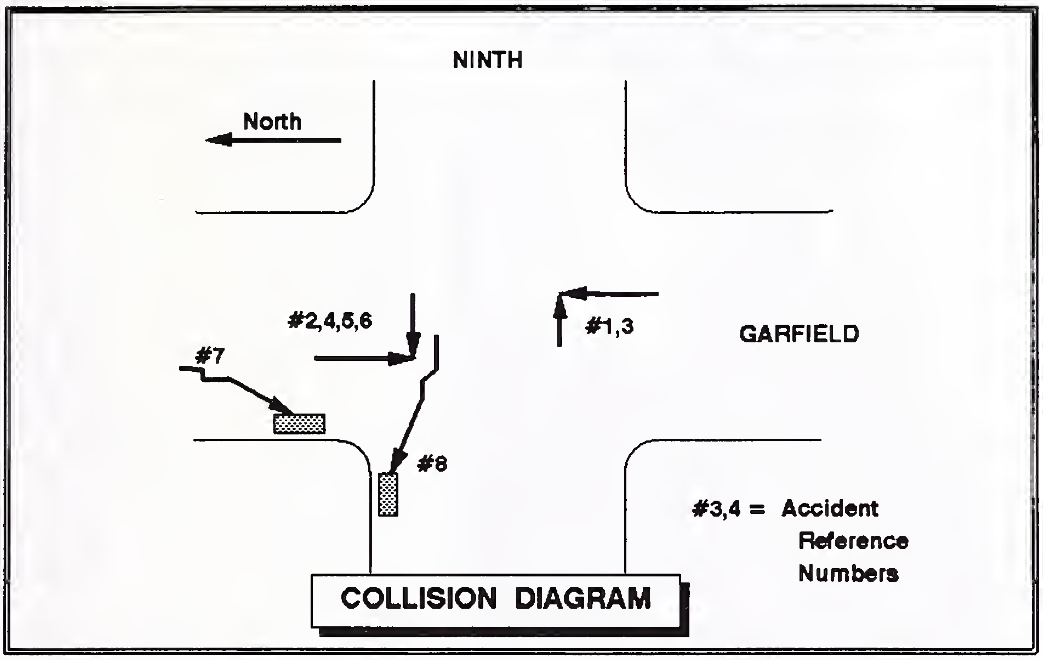
6

GARFIELD

and

NINTH

ACCIDENT SUMMARY
GARFIELD & NINTH



ACC NO.	ACCIDENT TYPE	MO.	DAY	YEAR	TIME	SEVERITY	WEATHER	ROAD	LIGHT
1	ANGLE	9	1	88	1536	INJURY	CLEAR	DRY	DAY
2	ANGLE	12	17	90	1357	PROP DAM	CLEAR	ICY	DAY
3	ANGLE	2	9	91	1314	PROP DAM	CLEAR	ICY	DAY
4	ANGLE	3	2	91	1631	PROP DAM	CLEAR	WET	DAY
5	ANGLE	11	14	91	1927	INJURY	CLEAR	DRY	NITE
6	ANGLE	12	8	91	1015	PROP DAM	RAIN	WET	DAY
7	PARKED VEH	1	21	91	1644	PROP DAM	CLEAR	ICY	DAY
8	PARKED VEH	5	15	91	1500	PROP DAM	CLEAR	DRY	DAY

ACCIDENT STATISTICS

NO. ACC.	YEAR		
1	1988	#INJ ACC	2
0	1989	#FAT ACC	0
1	1990	#PDO ACC	6
6	1991	PERSON =	2 *
8	TOTAL	NIGHTIME	13%

* No. of Persons Injured

TYPES	NUMBER	ROAD	
ANGLE	6	DRY	38%
REAR END	0	WET	25%
SIDESWIPE	0	SNOW	0%
LEFT TRN	0	ICE	38%
OTHER	2	OTHER	0%

Looking North

GARFIELD

Looking South

Looking East

NINTH

Looking West

TRAFFIC OPERATIONS

Garfield is a local north-south street which has continuity from 14th Street on the south to 3rd Street on the north. Ninth Street is a local east-west street which is continuous from Russell on the east to Johnson on the west. Their intersection is typical of most intersections within this mostly residential area. Because of the low volume nature of these streets, no particular conflicts were observed. Low growing tree vegetation in the southwest corner of the intersection prevents a clear line of vision through the corner of the intersection and a fence in the northeast corner is more of a distraction rather than an obstruction. Neither yellow curbs nor parking signs are present.

Accidents types included six angle accidents and two accidents involving parked vehicles near the intersection. The majority of accidents occurred of roadway conditions that were not dry.

IMPROVEMENTS

Sight distance at this intersection can be improved by trimming trees which currently provide an obstruction. Since most of the accidents were on less than ideal roadway conditions, traffic and sight distance conditions must be such that the margin for error by drivers is very slim. To lessen that margin, yield signs could be used as a first level control effort. However, yield signs are not used at conventional intersections in Missoula and for the sake of consistency, they should not be introduced. Considering the extremely high accident rate at this intersection, additional control appears warranted.
Therefore, it is recommended that stop signs be placed on the lower volume Ninth Street. Yellow curbs should be painted in the intersection area to reduce the possibility of vehicles parking too close to the intersection. The city may also want to review the maintenance requirements in this area during inclement weather.

Long term improvements do not appear to be applicable to the conditions encountered at this site.

GARFIELD & NINTH

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	500
SOUTH APP	500
EAST APP	200
WEST APP	250

EXISTING CONTROL:

NONE	
YIELD	
STOP	
SIGNAL	■

RECOMMENDED CONTROL:

PARKING	YES
YEILD	
STOP	YES
WALK	
MARKING	
WARNING	
REGULATORY	

ESTIMATED COST:

TOTAL	$595
MDoT FUND	$445
CITY FUND	$150

% ACCIDENT REDUCTION:

	NUMBER	PERCENT
INJ/FTL	1.0	50%
PDO	2.2	37%

BENEFIT/COST RATIO: 25

	INDEX VALUE	SITE RANK
# ACCIDENTS	61	10
ACCIDENT RATE	100	2
SEVERITY	46	16
VOL/CAPACITY	9	24
SIGHT DIST.	28	25
DRIVER EXPECT	50	24
INFO DEFICIENT	50	23
HAZARD INDEX	57	11
B/C RATIO	70	3

PRIORITY	61.3	6

SITE

NUMBER

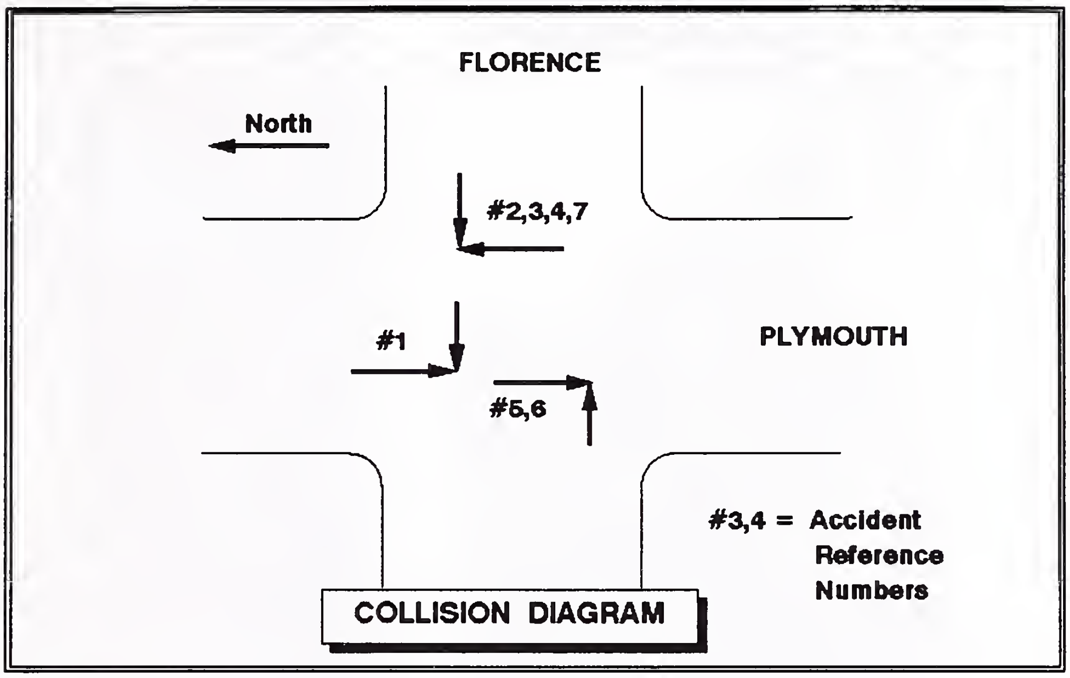
7

PLYMOUTH

and

FLORENCE

ACCIDENT SUMMARY
PLYMOUTH & FLORENCE



ACCIDENT KEY

ACC NO.	ACCIDENT TYPE	MO.	DAY	YEAR	TIME	SEVERITY	WEATHER	ROAD	LIGHT
1	ANGLE	5	19	88	742	PROP DAM	CLEAR	WET	DAY
2	ANGLE	1	26	90	1316	INJURY	SNOW	ICY	DAY
3	ANGLE	1	26	90	1541	PROP DAM	CLEAR	ICY	DAY
4	ANGLE	2	8	90	1040	PROP DAM	CLEAR	SNOW	DAY
5	ANGLE	12	21	90	1151	PROP DAM	CLEAR	ICY	DAY
6	ANGLE	11	19	91	809	PROP DAM	CLEAR	ICY	DAY
7	ANGLE	12	4	91	829	PROP DAM	CLEAR	ICY	DAY

ACCIDENT STATISTICS

NO. ACC.	YEAR			
1	1988	#INJ ACC	1	
0	1989	#FAT ACC	0	
4	1990	#PDO ACC	6	
2	1991	PERSON =	1	*
7	TOTAL	NIGHTIME	0%	

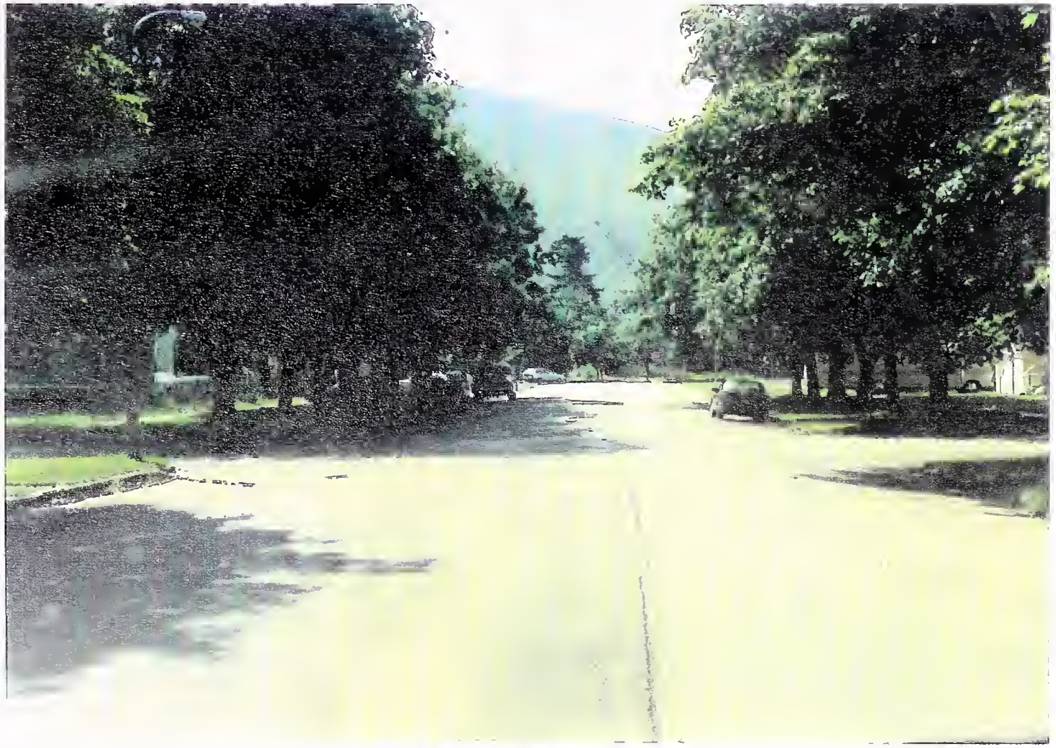
* No. of Persons Injured

TYPES	NUMBER	ROAD	
ANGLE	7	DRY	-0%
REAR END	0	WET	20%
SIDESWIPE	0	SNOW	0%
LEFT TRN	0	ICE	80%
OTHER	0	OTHER	0%

Looking North

Looking South

PLYMOUTH



Looking East

Looking West

FLORENCE

TRAFFIC OPERATIONS

Plymouth and Florence are both local streets within an area of town where the grid patterns parallels Brooks Street (formerly US 93). Florence runs in a northwest by southeast direction while Plymouth runs in a northeast by southwest direction. For the purposes of discussion, all references to Plymouth will be in a north-south direction. The intersection is located in a residential area two blocks west of Higgins, which is an arterial street. Traffic operations indicate that traffic from east of the intersection crossing Higgins or coming off Higgins onto Florence, tends to be traveling faster than other traffic approaches to this intersection. This traffic may be coming from streets near the university and drivers are attempting to access Brooks by using Florence as one of several short cut streets. There are no marked parking restrictions at the intersection. Intersection sight distance is partially obscured by mature tee trunks.

Seven angle accidents, 5 of which involve the westbound movement, compose the total accident experience at this low volume intersection. All of the accidents occurred on wet icy streets at times coincident with students departures and arrivals.

IMPROVEMENTS

Since there is a definite perceived direction of thru traffic at this intersection and there are no permanent and complete sight obstacles, it is recommended that stop signs be placed on the Plymouth Street approaches. Clear lines of sight must be insured by marking the curb within the restricted intersection no parking zones. Obviously, reduced road friction during inclement weather is enough to exceed the margin of safety at this intersection. The city may want to review its winter maintenance policy at this particular intersection.

Long term improvements at this location may be benefited if development of a new east-west corridor between the university and arterial streets to the west is implemented.

PLYMOUTH & FLORENCE

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	400
SOUTH APP	300
EAST APP	400
WEST APP	450

EXISTING CONTROL:

NONE	
YIELD	
STOP	
SIGNAL	■

RECOMMENDED CONTROL:

PARKING	YES
YEILD	
STOP	YES
WALK	
MARKING	
WARNING	
REGULATORY	

ESTIMATED COST:

TOTAL	$425
MDoT FUND	$275
CITY FUND	$150

% ACCIDENT REDUCTION:

	NUMBER	PERCENT
INJ/FTL	0.6	60%
PDO	3.6	60%

BENEFIT/COST RATIO: 24

	INDEX VALUE	SITE RANK
# ACCIDENTS	58	13
ACCIDENT RATE	93	4
SEVERITY	42	22
VOL/CAPACITY	13	20
SIGHT DIST.	28	24
DRIVER EXPECT	67	15
INFO DEFICIENT	50	22
HAZARD INDEX	57.1	10
B/C RATIO	69	4

PRIORITY	61	7

SITE

NUMBER

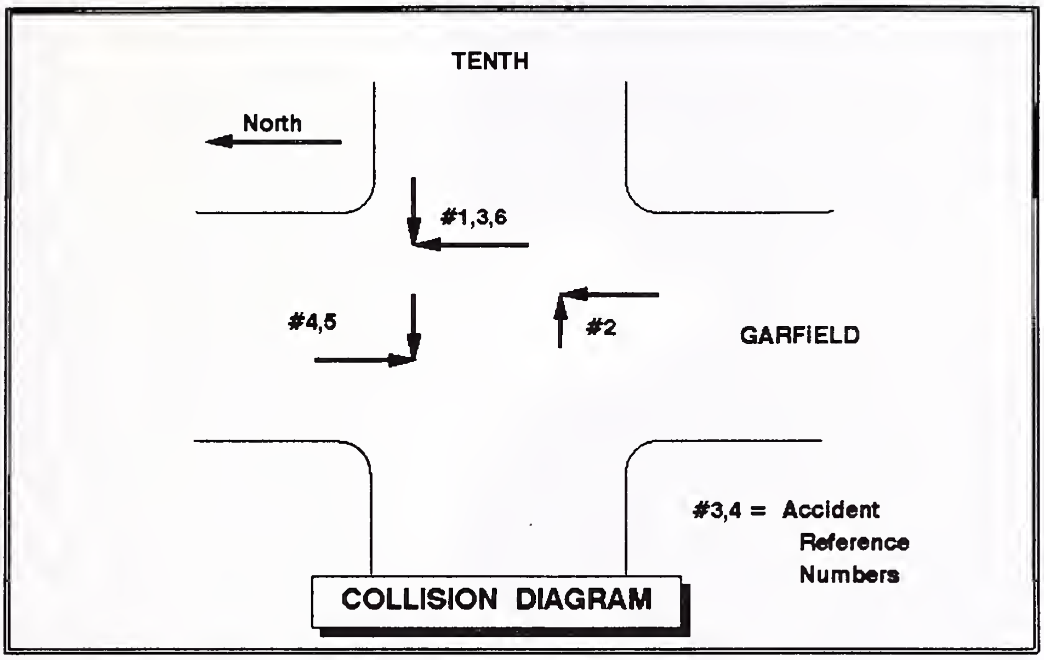
8

GARFIELD

and

TENTH

ACCIDENT SUMMARY
GARFIELD & TENTH



ACC NO.	ACCIDENT TYPE	MO.	DAY	YEAR	TIME	SEVERITY	WEATHER	ROAD	LIGHT
		ACCIDENT KEY							
1	ANGLE	10	14	88	1050	PROP DAM	CLEAR	DRY	DAY
2	ANGLE	2	21	89	1808	PROP DAM	CLEAR	SNOW	DAY
3	ANGLE	1	25	90	1300	INJURY	CLEAR	DRY	DAY
4	ANGLE	4	30	91	1026	PROP DAM	CLEAR	DRY	DAY
5	ANGLE	5	26	91	2201	PROP DAM	CLEAR	DRY	NITE
6	ANGLE	6	12	91	1611	INJURY	CLEAR	DRY	DAY

ACCIDENT STATISTICS

NO. ACC.	YEAR		
1	1988	#INJ ACC	2
1	1989	#FAT ACC	0
1	1990	#PDO ACC	4
3	1991	PERSON =	2 *
6	TOTAL	NIGHTIME	17%

* No. of Persons Injured

TYPES	NUMBER	ROAD	
ANGLE	6	DRY	83%
REAR END	0	WET	0%
SIDESWIPE	0	SNOW	17%
LEFT TRN	0	ICE	0%
OTHER	0	OTHER	0%

Looking North

Looking South

GARFIELD

Looking East

Looking West

TENTH

TRAFFIC OPERATIONS

Garfield is a local north-south street which has continuity from 14th Street on the south to 3rd Street on the north. Tenth Street is a local east-west street which is continuous from Russell on the east to Johnson on the west. Their intersection is not typical of most intersections within this area. A church in the northeast corner of the intersection is crammed into a residential neighborhood and in order to provide parking, the normal boulevard area has been paved to accommodate perpendicular parking. Sight distance at times when no vehicles are parked is sufficient for an uncontrolled intersection. When cars are parked near the intersection, sight distance would be minimal. The opportunity to observe traffic operations when the parking areas were full, was not presented.

There were six accidents at this intersection during the study reporting period. All of these accidents were angle type. The accidents did not occur on anyone particular day of the week. All but one of the accidents involved westbound vehicles. Three of those were with southbound vehicles on the opposite side of the corner parking area. Those accidents may easily be explained by the Misdirected Attention Syndrome, which is the tendency of drivers to focus attention toward a known situation while exposing themselves to conflict form the opposite direction.

IMPROVEMENTS

Sight distance at this intersection must be improved by eliminating parking within the intersections sight triangle. In order to do this, new curb sections must be constructed in the northeast quadrant of the intersection to match the opposite curblines. This will eliminate 6 to 7 parking spaces. Although the existing parking spaces are in the city's right-of-way, the church should be contacted so that they may be able to plan for the loss. Traffic volumes on the approaches are not significantly different on an average daily basis but may be significantly different during peak hour times of the day. Because of a the potential for intense conflicts created by unusual vehicular and pedestrian activity in this area, it is also recommended that stop signs be installed on the Tenth Street approaches. No parking zones should also be marked to avoid periodic sight distance problems caused by vehicles parked too close to the intersection.

GARFIELD & TENTH

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	500
SOUTH APP	550
EAST APP	400
WEST APP	400

EXISTING CONTROL:

NONE	
YIELD	
STOP	
SIGNAL	■

RECOMMENDED CONTROL:

PARKING	YES
YEILD	
STOP	YES
WALK	YES
MARKING	
WARNING	
REGULATORY	

ESTIMATED COST:

TOTAL	$2,010
MDoT FUND	$460
CITY FUND	$1,550

% ACCIDENT REDUCTION:

	NUMBER	PERCENT
INJ/FTL	1.2	60%
PDO	2.4	60%

BENEFIT/COST RATIO: 16

	INDEX VALUE	SITE RANK
# ACCIDENTS	54	17
ACCIDENT RATE	76	6
SEVERITY	55	5
VOL/CAPACITY	6	25
SIGHT DIST.	67	18
DRIVER EXPECT	58	21
INFO DEFICIENT	50	24
HAZARD INDEX	56.1	12
B/C RATIO	61	10

PRIORITY	57.7	8

SITE

NUMBER

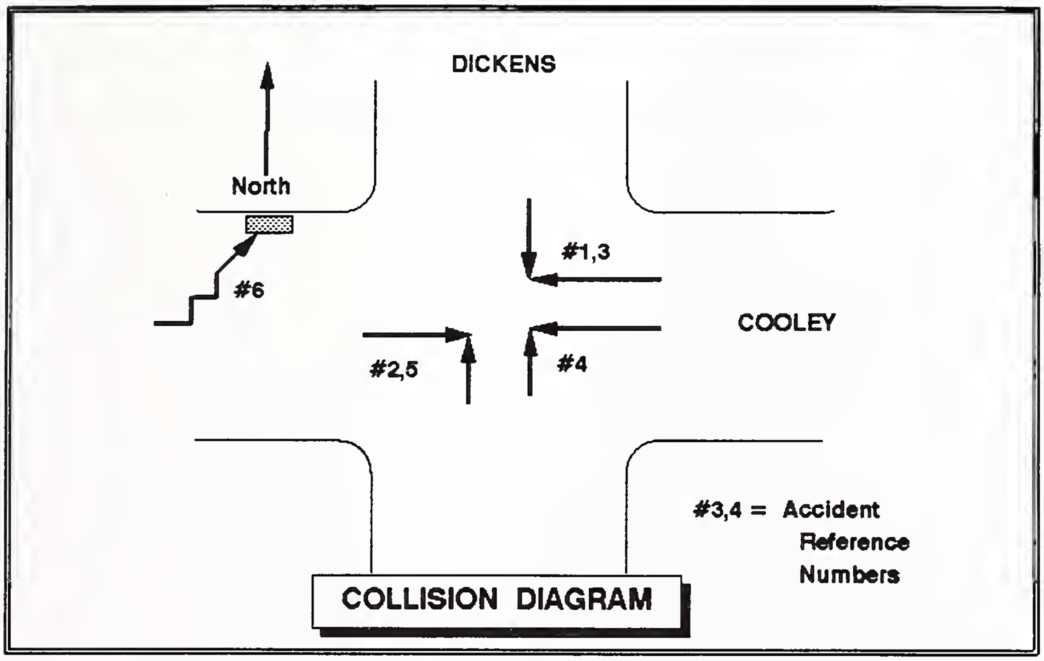
9

COOLEY

and

DICKENS

ACCIDENT SUMMARY
COOLEY & DICKENS



ACCIDENT KEY

ACC NO.	ACCIDENT TYPE	MO.	DAY	YEAR	TIME	SEVERITY	WEATHER	ROAD	LIGHT
1	ANGLE	3	8	89	1427	PROP DAM	CLEAR	WET	DAY
2	ANGLE	2	23	90	1951	PROP DAM	CLEAR	DRY	NITE
3	ANGLE	4	9	90	1947	PROP DAM	CLEAR	DRY	DAY
4	ANGLE	11	9	90	1731	PROP DAM	CLEAR	DRY	NITE
5	ANGLE	9	9	91	1015	INJURY	CLEAR	DRY	DAY
6	PARKED VEH	11	29	90	1605	INJURY	CLEAR	WET	DAY

ACCIDENT STATISTICS

NO. ACC.	YEAR		
0	1988	#INJ ACC	2
1	1989	#FAT ACC	0
4	1990	#PDO ACC	4
1	1991	PERSON =	3 *
6	TOTAL	NIGHTIME	33%

* No. of Persons Injured

TYPES	NUMBER	ROAD	
ANGLE	5	DRY	83%
REAR END	0	WET	17%
SIDESWIPE	0	SNOW	0%
LEFT TRN	0	ICE	0%
OTHER	1	OTHER	0%

Looking North

DICKENS

Looking South


Looking East

COOLEY


Looking West From Dickens

TRAFFIC OPERATIONS

Cooley and Dickens are both local streets. Cooley runs in an east-west direction and is continuous for 6 city blocks. Dickens runs north-south and has continuity for 7 city blocks. Cooley has traffic volumes approximately three times that of Dickens. A wire fence and bush in the southwest corner constitutes an intrusion into the required sight triangle for stop controlled intersections. Numerous vehicles, which restrict sight distance, are also parked directly behind the curb in the northwest corner of the intersection. There is evidence that vehicles may also park near the stops signs on both approaches. The stop signs are clearly visible on approach to the intersection, but may not capture driver's attention as much as they could. Speeds on Cooley approach 35 mph as the upper pace limit. This is significantly faster than speeds on other area streets. The City of Missoula may want to confirm these observations with a speed study.

Five of the six accidents at this intersection were angle accidents that could be attributed to the above noted sight restrictions or to the lack of stop sign visibility. A significant number of accidents occurred at night or in hours of dusk. Cooley has street lights, which may indicate that the stop signs are less obvious during poor lighting conditions.

IMPROVEMENTS

Since sight restrictions prevent drivers from entering the intersection without full knowledge of potential conflicts, the sight restrictions must be removed. It is not known whether the wire fence is located within the street right-of-way, but it appears to be. The city should require the owner to move the fence to his property line, if so. The bush in his yard should be removed completely. Vehicles parked behind the curb in the northwest corner should be permanently moved out of the line of sight. Parking restrictions on Cooley should be marked consistent with vehicle approach speeds at the intersection. No parking signs should be place 30' in front of the stop signs to prevent blockage by parked vehicles. To improve stop sign visibility new 36" signs should replace the existing 30" signs. The centerline on Cooley should be restriped as double yellow. Intersections in this area are too close to allow passing between intersections.

COOLEY & DICKENS

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	300
SOUTH APP	300
EAST APP	1000
WEST APP	1100

EXISTING CONTROL:

NONE	
YIELD	
STOP	YES
SIGNAL	

RECOMMENDED CONTROL:

PARKING	YES
YEILD	
STOP	YES
CURB/WALK	
MARKING	YES
WARNING	
REGULATORY	

ESTIMATED COST:

TOTAL	$900
MDoT FUND	$660
CITY FUND	$240

% ACCIDENT REDUCTION:

	NUMBER	PERCENT
INJ/FTL	0.7	35%
PDO	2.4	60%

BENEFIT/COST RATIO: 18

	INDEX VALUE	SITE RANK
# ACCIDENTS	54	15
ACCIDENT RATE	58	7
SEVERITY	55	4
VOL/CAPACITY	11	21
SIGHT DIST.	100	14
DRIVER EXPECT	50	23
INFO DEFICIENT	50	25
HAZARD INDEX	53.7	14
B/C RATIO	62	9

PRIORITY	56.4	9

SITE

NUMBER

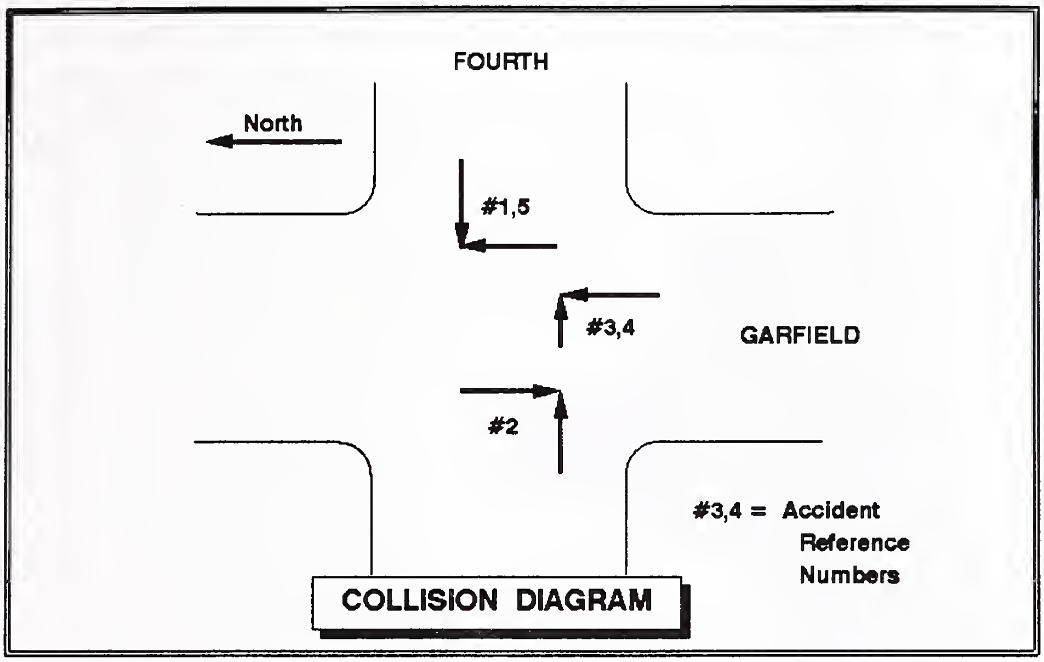
10

GARFIELD

and

FOURTH

ACCIDENT SUMMARY
GARFIELD & FOURTH



ACCIDENT KEY

ACC NO.	ACCIDENT TYPE	MO.	DAY	YEAR	TIME	SEVERITY	WEATHER	ROAD	LIGHT
1	ANGLE	8	21	88	1202	PROP DAM	CLEAR	DRY	DAY
2	ANGLE	8	26	88	1211	INJURY	CLEAR	DRY	DAY
3	ANGLE	9	30	88	1841	PROP DAM	CLEAR	DRY	DAY
4	ANGLE	7	13	89	2044	PROP DAM	CLEAR	DRY	DAY
5	ANGLE	5	8	91	1019	PROP DAM	RAIN	WET	DAY

ACCIDENT STATISTICS

NO. ACC.	YEAR		
3	1988	#INJ ACC	1
1	1989	#FAT ACC	0
0	1990	#PDO ACC	4
1	1991	PERSON =	1 *
5	TOTAL	NIGHTIME	0%

* No. of Persons Injured

TYPES	NUMBER	ROAD	
ANGLE	5	DRY	80%
REAR END	0	WET	20%
SIDESWIPE	0	SNOW	0%
LEFT TRN	0	ICE	0%
OTHER	0	OTHER	0%


Looking North From 4th


Looking South

GARFIELD


Looking East


Looking West

FOURTH

TRAFFIC OPERATIONS

Garfield is a local north-south street which has continuity from 14th Street on the south to 3rd Street on the north. Fourth Street is a local east-west street which is continuous from Russell on the east to Johnson, two blocks west of this intersection. Their intersection is not typical of most intersections within this area. Third Street is a busy arterial and is located just one block north of the intersection, and Fifth Street is a collector, one block south. Vehicles on Garfield, at this intersection, are normally between the intersections as part of a longer trip length and do not expect an uncontrolled intersection on this street section. A fence and trees in the northwest corner of the intersection severely restrict sight distance. A sharp vertical curve is also located on the north edge of the intersection. Cars parked in the southwest corner of the intersection are located too close to the intersection area.

There were five accidents at this intersection during the study reporting period. All of these accidents were angle type. The accidents did not occur on anyone particular day of the week. All but one of the accidents involved northbound vehicles. Three of those were with eastbound vehicles on the opposite side of the corner parking area. Those accidents may easily be explained by the Misdirected Attention Syndrome, which is the tendency of drivers to focus attention toward a known situation while exposing themselves to conflict from the opposite direction. The other accidents may be a result of vehicles parked near the intersection.

IMPROVEMENTS

In this particular case, improving sight distance alone would not totally eliminate potential for accidents. The nature of traffic operations on Garfield along with significantly larger traffic volumes requires installation of stop signs on Fourth. Sight distance should also be improved by trimming the trees in the northwest corner and marking appropriate no parking zones in the intersection area. Significant safety improvements could be expected from implementing these recommendations.

Long term improvements may not be practical at this location.

GARFIELD & FOURTH

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	1700
SOUTH APP	1600
EAST APP	500
WEST APP	700

EXISTING CONTROL:

NONE	
YIELD	
STOP	
SIGNAL	

RECOMMENDED CONTROL:

PARKING	YES
YEILD	
STOP	YES
CURB/WALK	
MARKING	
WARNING	
REGULATORY	

ESTIMATED COST:

TOTAL	$595
MDoT FUND	$445
CITY FUND	$150

% ACCIDENT REDUCTION:

	NUMBER	PERCENT
INJ/FTL	0.7	70%
PDO	2.8	70%

BENEFIT/COST RATIO: 20

	INDEX VALUE	SITE RANK
# ACCIDENTS	50	22
ACCIDENT RATE	34	10
SEVERITY	44	19
VOL/CAPACITY	23	17
SIGHT DIST.	67	17
DRIVER EXPECT	83	3
INFO DEFICIENT	67	9
HAZARD INDEX	51	20
B/C RATIO	65	6

PRIORITY	55.6	10

SITE

NUMBER

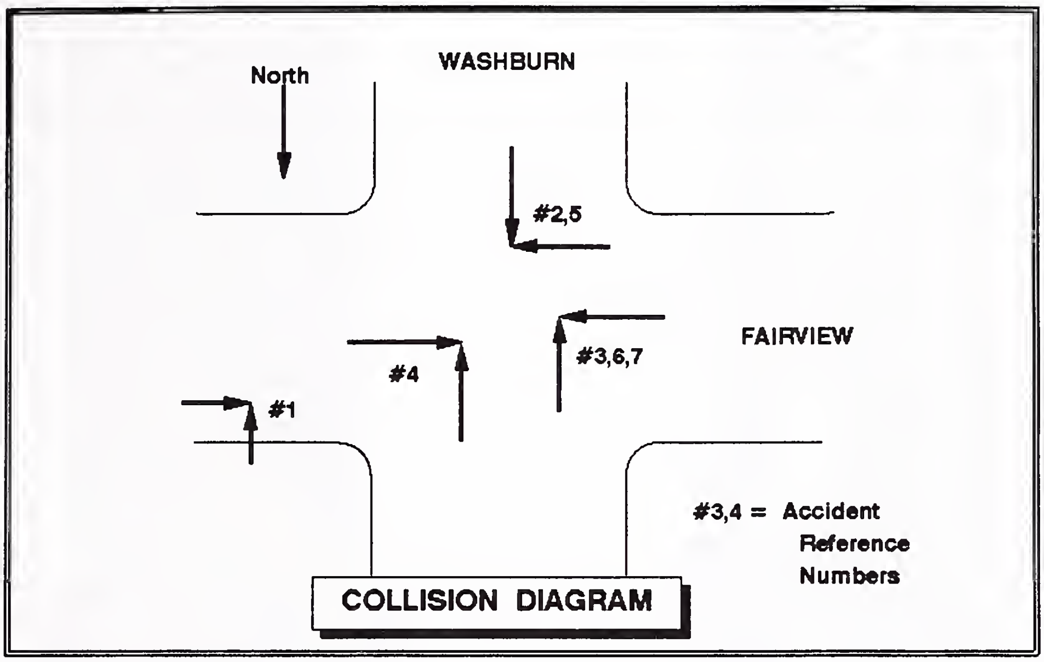
11

FAIRVIEW

and

WASHBURN

ACCIDENT SUMMARY
FAIRVIEW & WASHBURN



ACCIDENT KEY

ACC NO.	ACCIDENT TYPE	MO.	DAY	YEAR	TIME	SEVERITY	WEATHER	ROAD	LIGHT
1	ANGLE	2	20	88	1243	INJURY	CLEAR	DRY	DAY
2	ANGLE	5	2	88	1327	INJURY	CLEAR	DRY	DAY
3	ANGLE	5	13	88	2012	PROP DAM	CLEAR	DRY	NITE
4	ANGLE	3	31	89	1455	PROP DAM	CLEAR	DRY	DAY
5	ANGLE	4	14	90	1152	INJURY	RAIN	WET	DAY
6	ANGLE	11	21	91	1201	PROP DAM	CLEAR	DRY	DAY
7	ANGLE	12	16	91	1544	PROP DAM	CLEAR	DRY	DAY

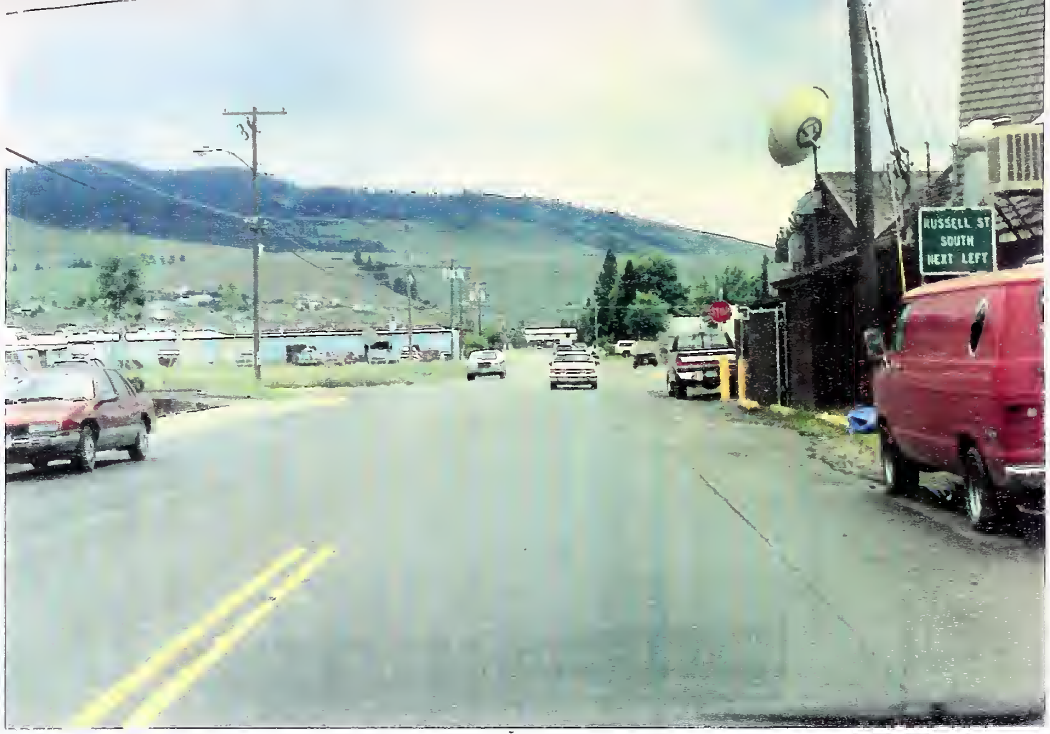
ACCIDENT STATISTICS

NO. ACC.	YEAR		
3	1988	#INJ ACC	3
1	1989	#FAT ACC	0
1	1990	#PDO ACC	4
2	1991	PERSON =	3 *
7	TOTAL	NIGHTIME	14%

* No. of Persons Injured

TYPES	NUMBER	ROAD	
ANGLE	7	DRY	86%
REAR END	0	WET	14%
SIDESWIPE	0	SNOW	0%
LEFT TRN	0	ICE	0%
OTHER	0	OTHER	0%

Looking North



Looking South

WASHBURN

Looking East

Looking West

FAIRVIEW

TRAFFIC OPERATIONS

Fairview is a local east-west street which does not have continuity across Missoula. At it's intersection with Washburn it is only continuous for three blocks. Washburn is a local north-south street which has continuity for nine blocks. The intersection of the two streets is only one block east of Brooks. Washburn functions as the prime access to Russell for southbound Brooks traffic, since left turns onto Russell from Brooks are prohibited.

Traffic on Fairview is nearly 3 times greater than that on Washburn. Turn lanes on Fairview provide a high level of service at this intersection. Parking is prohibited on Fairview and there is adequate sight distance in both direction from the stopped position on Washburn. A building in the northwest corner of the intersection, along with landscaping, partially block the line of site to the west on the southbound Washburn approach. Once stopped in the right location, no sight obstructions exist. From observations, it was noted that southbound drivers tend to focus their attention on the approach to the west and ignore traffic coming from the east. This situation is known as the "Misdirected Attention Syndrome" and is quite common especially in urban areas where a known or obvious sight obstruction exists. Since most northbound drivers on Washburn are coming off an arterial, they tend to drive the local street similar to the arterial and typically use the rolling stop method, which in this case does not allow them adequate time to focus on the line of sight in both directions and make the necessary decisions and driving adjustments. In addition, there are vehicles that park at the back of the building on the southbound approach near the stop sign. Although the sign is not blocked, the parked vehicles make it appear less prominent. The general appearance of this approach with the parked cars also distracts drivers by adding clutter. Delivery trucks also park in traffic lanes and obscure sight distance along with forcing drivers into errant maneuvers. This condition seems to be quite common in other areas of town as well.

Two of the seven angle accidents bear out the above noted operational problems at this intersection. Four of the other angle accidents are a result of drivers in the northbound direction who simply did not see the stop sign. Washburn south of the intersection is a wide curbless road where drivers have a tendency to travel faster than on any of the other approaches. The

stop sign, as seen in the photos on the preceding page, blends into the building colors in the background, and may not be noticeable at various periods of the day.

IMPROVEMENTS

In order to help improve recognition of the stop signs, it is recommended that the exist 30" stops be replaced with 36" stop signs. This will make them stand out among the background and roadside visual distractions. Stop bars will help reinforce the stop condition and hopefully aid southbound drivers in positioning their vehicles at a point where clear line of sight is obvious. Parking restriction signs should also be placed a minimum of 30 feet in advance of the stop signs to prevent parking in an area that would obscure or detract from the sign's visibility. The curb on the northbound approach should be extended another 25 feet and painted yellow to prevent vehicles from parking along and off the street shoulder.

Long term improvements at this site would be dependent upon whatever future improvements are made to Brooks Street. Substantial improvements to the Brooks - Russell - South intersection may preclude the need for using Washburn as a left turn lane.

FAIRVIEW & WASHBURN

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	1700
SOUTH APP	1300
EAST APP	2800
WEST APP	3800

EXISTING CONTROL:

NONE	
YIELD	
STOP	YES
SIGNAL	

RECOMMENDED CONTROL:

PARKING	YES
YEILD	
STOP	YES
CURB/WALK	YES
MARKING	YES
WARNING	
REGULATORY	

ESTIMATED COST:

TOTAL	$1,155
MDoT FUND	$765
CITY FUND	$390

% ACCIDENT REDUCTION:

	NUMBER	PERCENT
INJ/FTL	1.2	40%
PDO	1.8	40%

BENEFIT/COST RATIO: 15

	INDEX VALUE	SITE RANK
# ACCIDENTS	58	12
ACCIDENT RATE	26	15
SEVERITY	52	8
VOL/CAPACITY	47	13
SIGHT DIST.	100	5
DRIVER EXPECT	71	12
INFO DEFICIENT	54	20
HAZARD INDEX	53.1	17
B/C RATIO	58	11

PRIORITY	54.7	11

SITE

NUMBER

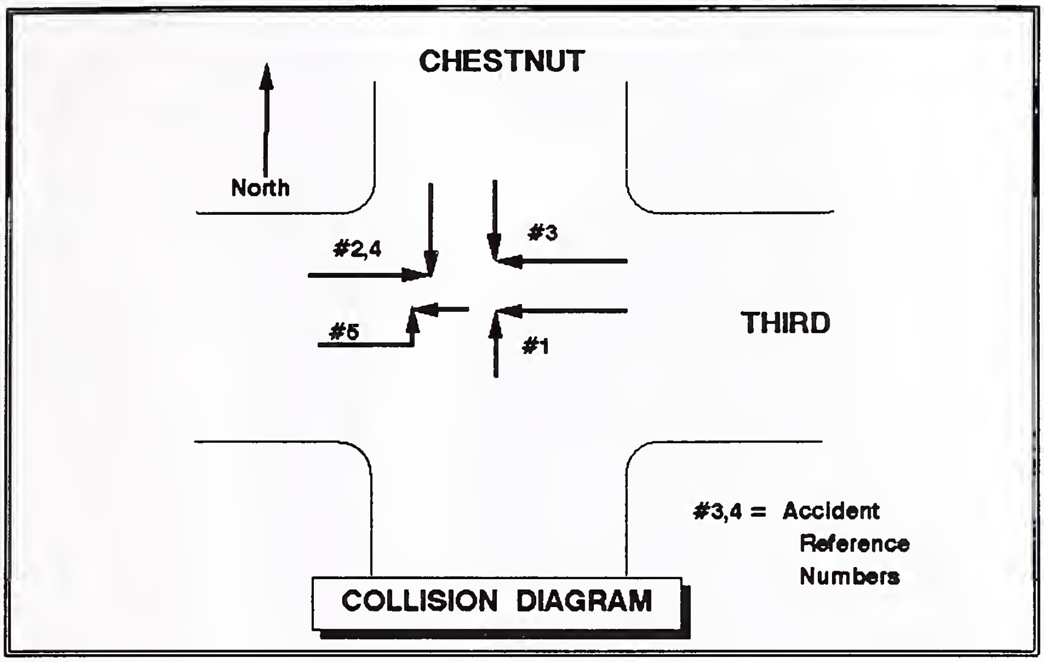
12

CHESTNUT

and

THIRD

ACCIDENT SUMMARY
CHESTNUT & THIRD



ACC NO.	ACCIDENT TYPE	MO.	DAY	YEAR	TIME	SEVERITY	WEATHER	ROAD	LIGHT
		ACCIDENT KEY							
1	ANGLE	2	9	88	1809	PROP DAM	CLEAR	WET	NITE
2	ANGLE	9	29	88	13	INJURY	CLEAR	DRY	NITE
3	ANGLE	9	24	89	1843	INJURY	CLEAR	DRY	DAY
4	ANGLE	7	10	91	1558	PROP DAM	CLEAR	DRY	DAY
5	LEFT TURN	9	11	91	1738	INJURY	CLEAR	DRY	DAY

ACCIDENT STATISTICS

NO. ACC.	YEAR		
2	1988	#INJ ACC	3
1	1989	#FAT ACC	0
0	1990	#PDO ACC	2
2	1991	PERSON =	3 *
5	TOTAL	NIGHTIME	40%

* No. of Persons Injured

TYPES	NUMBER	ROAD	
ANGLE	4	DRY	80%
REAR END	0	WET	20%
SIDESWIPE	0	SNOW	0%
LEFT TRN	1	ICE	0%
OTHER	0	OTHER	0%

Looking North

CHESTNUT

Looking South

Looking East

THIRD

Looking West

TRAFFIC OPERATIONS

Third Street is an east-west arterial and Chestnut is a local north-south street. Their intersection is in an older residential area of Missoula. The intersection site is similar to other intersections with Third Street in this area except that it is only one block east of a signalized intersection with Orange Street, a major north -south arterial. As is typical with this situation, drivers on Third tend to driver with all attention focused on the signal ahead and over drive the intersection immediately ahead.

The most obvious problem noted at this intersection was the lack of stop sign visibility because of low growing trees. Even without partial obstruction by tree branches, the stop signs are located in deep shadows created by the trees. In addition, the sign faces appear to be washed out.

Four out of the five accidents at this intersection were angle accidents representing most directions of travel. Accident reports indicate that all of them involved drivers failing to stop for the signs. Since forty percent of the accidents occurred at night, it is probable that stop sign visibility is the primary cause.

IMPROVEMENTS

In this particular case, improving stop sign visibility by trimming trees and replacing the signs with 36" oversize signs at a location nearer the intersection would have a dramatic effect on the accident experience. In addition, it is recommended that parking restrictions on Third be extended to account for the higher speeds encountered. A dynamic vehicle model indicates that parking should be prohibited at least 90 feet from the corner radius for the Third Street approaches.

Long term improvements may not be practical at this location.

CHESTNUT & THIRD

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	650
SOUTH APP	550
EAST APP	2100
WEST APP	2300

EXISTING CONTROL:

NONE	
YIELD	
STOP	YES
SIGNAL	

RECOMMENDED CONTROL:

PARKING	YES
YEILD	
STOP	YES
CURB/WALK	
MARKING	
WARNING	
REGULATORY	

ESTIMATED COST:

TOTAL	$880
MDoT FUND	$740
CITY FUND	$140

% ACCIDENT REDUCTION:

	NUMBER	PERCENT
INJ/FTL	1.0	33%
PDO	1.0	50%

BENEFIT/COST RATIO: 18

	INDEX VALUE	SITE RANK
# ACCIDENTS	50	19
ACCIDENT RATE	30	13
SEVERITY	57	3
VOL/CAPACITY	19	18
SIGHT DIST.	100	1
DRIVER EXPECT	50	25
INFO DEFICIENT	71	7
HAZARD INDEX	50.2	22
B/C RATIO	63	8

PRIORITY	54.4	12

SITE

NUMBER

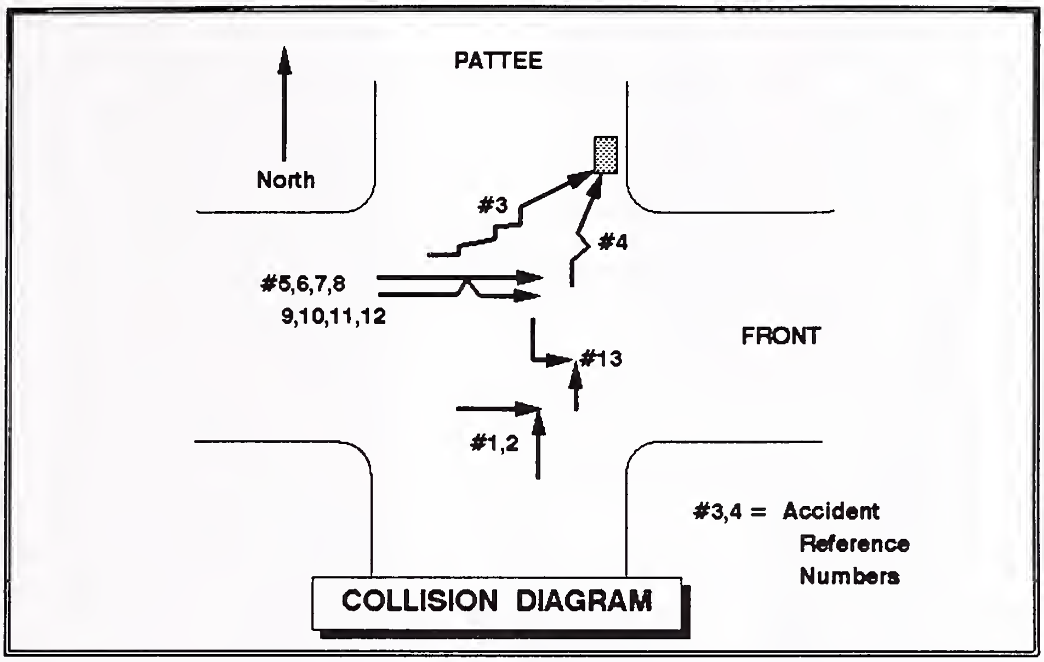
13

FRONT

and

PATTEE

ACCIDENT SUMMARY
FRONT & PATTEE



COLLISION DIAGRAM

ACCIDENT KEY

ACC NO.	ACCIDENT TYPE	MO.	DAY	YEAR	TIME	SEVERITY	WEATHER	ROAD	LIGHT
1	ANGLE	2	9	88	1949	INJURY	RAIN	WET	NITE
2	ANGLE	4	12	89	1320	PROP DAM	CLEAR	DRY	DAY
3	PARKED VEH	1	28	91	1547	PROP DAM	CLEAR	ICY	DAY
4	PARKED VEH	9	27	91	1307	PROP DAM	CLEAR	DRY	DAY
5	REAREND	3	15	91	2332	PROP DAM	CLEAR	DRY	NITE
6	SIDESWIPE	4	30	88	2353	PROP DAM	CLEAR	DRY	NITE
7	SIDESWIPE	3	14	89	1830	INJURY	CLEAR	DRY	DAY
8	SIDESWIPE	10	5	89	1619	PROP DAM	CLEAR	DRY	DAY
9	SIDESWIPE	1	10	90	1259	PROP DAM	CLEAR	DRY	DAY
10	SIDESWIPE	2	16	91	45	PROP DAM	CLEAR	WET	NITE
11	SIDESWIPE	5	17	91	1332	PROP DAM	CLEAR	DRY	DAY
12	SIDESWIPE	6	11	91	1753	PROP DAM	CLEAR	DRY	DAY
13	LEFT TURN	10	7	88	1647	PROP DAM	CLEAR	DRY	DAY

ACCIDENT STATISTICS

NO. ACC.	YEAR			
3	1988	#INJ ACC	2	
3	1989	#FAT ACC	0	
1	1990	#PDO ACC	11	
6	1991	PERSON =	2	*
13	TOTAL	NIGHTIME	31%	

*** No. of Persons Injured**

TYPES	NUMBER	ROAD	
ANGLE	2	DRY	77%
REAR END	1	WET	15%
SIDESWIPE	7	SNOW	0%
LEFT TRN	1	ICE	8%
OTHER	2	OTHER	0%

Looking North

PATTEE

Looking South

Looking East

FRONT

Looking West From Pattee

TRAFFIC OPERATIONS

The intersection of Front and Pattee is within the central business district (CBD) within the original townsite. Front is a one-way eastbound street and Pattee is a two-way north-south street. As a typical downtown intersection, it carries a large amount of downtown circulation traffic and pedestrians. Vehicle speeds tend to be in a range between 20 and 30 mph and frequent traffic flow interruptions are expected.

The most obvious operational problem noted at this site is street width and angle parking. It is similar to the Main & Ryman site except that parking on the south side of Front Street is parallel parking. Stop signs on Pattee are not entirely visible due to the location of the signs and parking conditions. Sight distance for vehicles stopped on Pattee is minimal, even when stopped within the crosswalks. Pedestrian crossings are difficult during the peak noon hour because of the wide crossing distance on Front Street and slightly higher vehicle speeds. In addition, it is difficult to perceive that Front is a one-way street from the side street if the one-way signs are not noticed.

There was a mixture of 13 accidents occurring during the reporting period at this site. Two angle accidents were associated with the difficulty of seeing to the east from the stopped position. Eight sideswipes accidents were a result of lane changes within the intersection area. There is a high percentage of left turns from Front Street and during observation periods, it was noted that left turns from the far lane accounted for approximately 10% of all those maneuvers. The remainder may be related to the general characteristics of the area.

IMPROVEMENTS

A traffic signal warrant analysis was completed for this site and can be found at the end of this section. The analysis indicates that a signal is not warranted at this location, but the pedestrian warrants for gaps is very near the necessary value and could be used as a warrant if this intersection were not within the influence of adjacent signals which creates crossing gaps.

The improvements recommended are intended to clear up the geometry of this intersection in order to eliminate sight restrictions and remove as many driver decisions as possible. Sidewalk bulbs at the intersection radii are recommended as the only way to improve sight distance in an angle parking environment while reducing the pedestrian crossing time and distance. It appears that there would be no net loss of parking spaces as a result of this recommendation.

The following are important reasons why this recommendation is made:

1. Curb bulbs at intersections provide a physical barrier which insures that vehicles will not park in the required line of sight. Experience has shown that painted and signed angle parking restrictions at intersections are frequently violated.

2. Curb bulbs allow side street vehicles to stop closer to the main street traffic lanes which reduces parking setbacks required for minimum sight distance on the main street. In the case of angle parking, where the number of parking spaces is critical, curb bulbs can save a substantial number of spaces.

3. Curb bulbs provide pedestrians a clear line of sight and a protected refuge while waiting for a traffic gap. The bulb sidewalk section also elevates pedestrians at a point where approaching traffic can see them.

4. Curb bulbs reduce the distance to cross the street and therefore, pedestrian crossing time is reduced significantly. Thus, the number of acceptable traffic gaps is increased.

5. Since the number of acceptable pedestrian crossing gaps are increased with curb bulbs, installation of traffic signals may be delayed if the signals are based on pedestrian crossing warrants.

6. Narrower street sections between the curb bulbs reduce pavement width and thus, better define the proper vehicles paths.

This tightens control and reduces the amount of area that vehicles have to make errant lane changes and turns from the wrong lane.

7. Curb bulbs allow a protected area in which stop signs and other traffic control devices can be located for maximum visibility.

8. Curb bulbs provide instant visual recognition of the exact intersection location for drivers, because they protrude into the street beyond the mid-block curbline. This recognition provides drivers with advanced information regarding vehicle positioning and navigation.

9. Curb bulbs provide an area for low growth landscaping which improves the aesthetic appearance of the intersection area and surrounding land use. The landscape area also encourages pedestrians to cross at the intersection throat rather than at locations prior to the intersection.

The recommended plan sketch, found in volume II of this report, indicates the associated traffic control devices considered necessary to implement maximum control of this intersection. Turn prohibition and one-way signs are located as typical in the Manual On Uniform Traffic Control Devices. Proper pavement markings, especially the solid lane line divider on the Front Street approach will help avoid lane change sideswipes. The centerline on Front Street should be moved south to allow for backing operations required by angle parking.

Long term improvements at this intersection are highly dependent upon the future vitality of the downtown area. If traffic volumes increase significantly over existing levels, a traffic signal may be warranted. If so, the short term improvements outlined herein will be completely adaptable.

FRONT & PATTEE

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	3100
SOUTH APP	2200
EAST APP	3800
WEST APP	3500

EXISTING CONTROL:

NONE	
YIELD	
STOP	YES
SIGNAL	

RECOMMENDED CONTROL:

PARKING	YES
YEILD	
STOP	YES
CURB/WALK	YES
MARKING	YES
WARNING	
REGULATORY	YES

ESTIMATED COST:

TOTAL	$8900
MDoT FUND	$1640
CITY FUND	$7260

% ACCIDENT REDUCTION:

	NUMBER	PERCENT
INJ/FTL	1.1	53%
PDO	4.0	36%

BENEFIT/COST RATIO: 4

	INDEX VALUE	SITE RANK
# ACCIDENTS	74	3
ACCIDENT RATE	34	9
SEVERITY	42	21
VOL/CAPACITY	87	5
SIGHT DIST.	100	4
DRIVER EXPECT	61	17
INFO DEFICIENT	89	1
HAZARD INDEX	61.5	6
B/C RATIO	31	17

PRIORITY	51.4	13

TRAFFIC SIGNAL WARRANT ANALYSIS
YEAR 1992
FRONT & PATTEE

WARRANT #1 - MINIMUM VEHICULAR VOLUME					
70% WARRANT		REQUIRED		EXISTS	
YES	NO	MAJOR	MINOR	MAJOR	MINOR
8TH HIGHEST HOUR		600	150	200	85
% OF WARRANT MET				33%	57%

WARRANT #2 - INTERRUPTION OF CONTINOUS TRAFFIC					
70% WARRANT		REQUIRED		EXISTS	
YES	NO	MAJOR	MINOR	MAJOR	MINOR
8TH HIGHEST HOUR		900	75	200	85
% OF WARRANT MET				22%	113%

WARRANT #3 - MINIMUM PEDESTRIAN TRAFFIC					
50% WARRANT		REQUIRED		EXISTS	
YES	NO	PEDS	GAPS	PEDS	GAPS
FOUR HOURS		100	60	60	80
PEAK HOUR		190	60	90	64
% OF WARRANT MET				47%	94%

WARRANT #4 - SCHOOL CROSSING [STUD	YES	NO

WARRANT #5 - PROGRESSIVE MOVEMENT	YES	NO

WARRANT #6 - ACCIDENT EXPERIENCE	YES	NO

WARRANT #7 - SYSTEMS WARRANT	YES	NO

WARRANT #8 - COMBINATION OF WARRANTS				
80 % OF	REQUIRED		EXISTS	
WARRANTS #1 & #2	MAJOR	MINOR	MAJOR	MINOR
WARRANT #1	480	120	200	85
WARRANT #2	720	60	200	85
% OF WARRANT MET			35%	106%

WARRANT #9 - FOUR HOUR VOLUMES				
	MAJOR	MINOR	CURVE NO.	WARRAN
4TH HIGHEST HOUR	270	120	FIGURE	YES
NUMBER OF LANES	2	1	4.7	NO

WARRANT #10 - PEAK HOUR DELAY				
PEAK HOUR:	MINOR LEG		TOTAL ENTERING	
	DELAY	VOLUME	4 LEGS	3 LEGS
REQUIRED VALUES	4	100	800	650
EXISTING VALUES	1.2	155	710	

WARRANT #11 - PEAK HOUR VOLUME				
	MAJOR	MINOR	CURVE NO.	WARRAN
PEAK HOUR	370	155	FIGURE	YES
NUMBER OF LANES	1	1	4.5	NO

SUMMARY OF WARRANTS SATISFIED					
WARRANT 1		WARRANT 5		WARRANT 9	
WARRANT 2		WARRANT 6		WARRANT 10	
WARRANT 3		WARRANT 7		WARRANT 11	
WARRANT 4		WARRANT 8		TOTAL =	0

PAGE 2 of 2

SITE

NUMBER

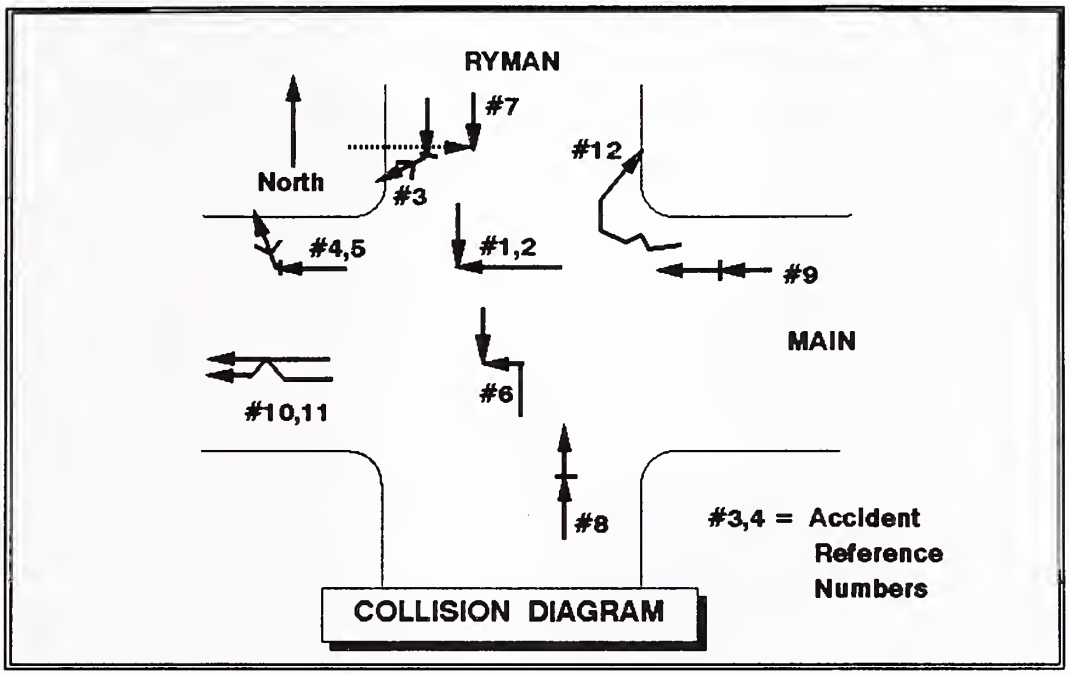
14

MAIN

and

RYMAN

ACCIDENT SUMMARY
MAIN & RYMAN



ACCIDENT KEY

ACC NO.	ACCIDENT TYPE	MO.	DAY	YEAR	TIME	SEVERITY	WEATHER	ROAD	LIGHT
1	ANGLE	5	8	90	905	PROP DAM	CLEAR	DRY	DAY
2	ANGLE	11	6	90	1330	PROP DAM	CLEAR	DRY	DAY
3	BACKING	6	25	88	2145	PROP DAM	CLEAR	DRY	DAY
4	BACKING	2	27	90	1704	INJURY	CLEAR	DRY	DAY
5	BACKING	12	22	90	1311	PROP DAM	CLEAR	ICY	DAY
6	LEFT TURN	12	12	90	1426	PROP DAM	CLEAR	DRY	DAY
7	PEDESTRIAN	4	29	89	2357	PROP DAM	CLEAR	DRY	NITE
8	REAREND	8	22	89	159	PROP DAM	CLEAR	DRY	NITE
9	REAREND	12	7	89	1521	INJURY	CLEAR	DRY	DAY
10	SIDESWIPE	2	16	88	1530	PROP DAM	CLEAR	WET	DAY
11	SIDESWIPE	11	10	89	1954	INJURY	CLEAR	DRY	DAY
12	SINGLE VEH	8	27	88	215	PROP DAM	CLEAR	DRY	NITE

ACCIDENT STATISTICS

NO. ACC.	YEAR		
3	1988	#INJ ACC	3
4	1989	#FAT ACC	0
5	1990	#PDO ACC	9
0	1991	PERSON =	3 *
12	TOTAL	NIGHTIME	0%

*** No. of Persons Injured**

TYPES	NUMBER	ROAD	
ANGLE	2	DRY	83%
REAR END	2	WET	8%
SIDESWIPE	2	SNOW	0%
LEFT TRN	1	ICE	8%
OTHER	5	OTHER	0%

Looking North

Looking South

RYMAN

Looking East From Ryman

Looking West

MAIN

TRAFFIC OPERATIONS

The intersection of Main and Ryman is within the central business district (CBD) in the original townsite. Main is a one-way westbound street and Ryman is a two-way north-south street. As a typical downtown intersection, it carries a large amount of downtown circulation traffic and pedestrians. Vehicle speeds tend to be in a range between 20 and 30 mph and frequent traffic flow interruptions are expected.

The most obvious operational problem noted at this site is street width and angle parking. Stop signs on Ryman are not entirely visible due to street geometry. Parking conditions along Main and related sight distance for vehicles stopped on Ryman is minimal, even when vehicles stop within the crosswalks. The existing stop signs also appear to be washed out and dull. Pedestrian crossings are not possible during the peak noon hour without side stepping vehicles because of the wide crossing distance on Main Street. In addition, it is difficult to perceive that Main is a one-way street from the side street if one-way signs are not noticed.

There was a mixture of 12 accidents occurring during the reporting period at this site. Two angle accidents were associated with the difficulty of seeing to the west from the stopped position. Two backing accidents are typical of angle parking characteristics. Two sideswipes accidents were a result of lane changes within the intersection area. Two rearend accidents could be attributed to pedestrian crossings, angle parking maneuvers or limited sight distance. The pedestrian accident was related to angle parking and the remaining may be related to the general characteristics of the area.

IMPROVEMENTS

A traffic signal warrant analysis was completed for this site and can be found at the end of this section. The analysis indicates that a signal is not warranted at this location, but the pedestrian warrants for gaps could be used as a warrant if this intersection were not within the influence of adjacent signals, which create crossing gaps.

The improvements recommended are intended to clear up the geometry of this intersection, in order to eliminate sight restrictions and remove as many driver decisions as possible. Sidewalk bulbs at the intersection radii are recommended as the only way to improve sight distance in an angle parking environment. The following are important reasons why this recommendation is made:

1. Curb bulbs at intersections provide a physical barrier which insures that vehicles will not park in the required line of sight. Experience has shown that painted and signed angle parking restrictions at intersections are frequently violated.

2. Curb bulbs allow side street vehicles to stop closer to the main street traffic lanes which reduces parking setbacks required for minimum sight distance on the main street. In the case of angle parking, where the number of parking spaces is critical, curb bulbs can save a substantial number of spaces.

3. Curb bulbs provide pedestrians a clear line of sight and a protected refuge while waiting for a traffic gap. The bulb sidewalk section also elevates pedestrians at a point where approaching traffic can see them.

4. Curb bulbs reduce the distance to cross the street and therefore, pedestrian crossing time is reduced significantly. Thus, the number of acceptable traffic gaps is increased.

5. Since the number of acceptable pedestrian crossing gaps are increased with curb bulbs, installation of traffic signals may be delayed if the signals are based on pedestrian crossing warrants.

6. Narrower street sections between the curb bulbs reduce pavement width and thus, better define the proper vehicles paths. This tightens control and reduces the amount of area that vehicles have to make errant lane changes and turns from the wrong lane.

7. Curb bulbs allow a protected area in which stop signs and other traffic control devices can be located for maximum visibility.

8. Curb bulbs provide instant visual recognition of the exact intersection location for drivers, because they protrude into the street beyond the mid-block curbline. This recognition provides drivers with advanced information regarding vehicle positioning and navigation.

9. Curb bulbs provide an area for low growth landscaping which improves the aesthetic appearance of the intersection area and surrounding land use. The landscape area also encourages pedestrians to cross at the intersection throat rather than at locations prior to the intersection.

The recommended plan sketch, found in volume II of this report, indicates the associated traffic control devices considered necessary to implement maximum control of this intersection. Turn prohibition and one-way signs are located as typical in the Manual On Uniform Traffic Control Devices. Proper pavement markings, especially the solid lane line divider on the Main Street approach will help avoid lane change sideswipes.

Long term improvements at this intersection are highly dependent upon the future vitality of the downtown area. If traffic volumes increase significantly over existing levels, a traffic signal may be warranted. If so, the short term improvements outlined herein will be completely adaptable.

MAIN & RYMAN

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	2900
SOUTH APP	3000
EAST APP	5400
WEST APP	5500

EXISTING CONTROL:

NONE	
YIELD	
STOP	YES
SIGNAL	

RECOMMENDED CONTROL:

PARKING	YES
YEILD	
STOP	YES
CURB/WALK	YES
MARKING	YES
WARNING	
REGULATORY	YES

ESTIMATED COST:

TOTAL	$10,900
MDoT FUND	$1440
CITY FUND	$9460

% ACCIDENT REDUCTION:

	NUMBER	PERCENT
INJ/FTL	1.2	40%
PDO	4.0	44%

BENEFIT/COST RATIO: 4

	INDEX VALUE	SITE RANK
# ACCIDENTS	72	5
ACCIDENT RATE	25	17
SEVERITY	46	17
VOL/CAPACITY	78	8
SIGHT DIST.	100	6
DRIVER EXPECT	83	6
INFO DEFICIENT	72	5
HAZARD INDEX	60.4	7
B/C RATIO	30	18

PRIORITY	50.4	14

TRAFFIC SIGNAL WARRANT ANALYSIS
YEAR 1992
MAIN & RYMAN

WARRANT #1 - MINIMUM VEHICULAR VOLUME					
70% WARRANT		REQUIRED		EXISTS	
YES	NO	MAJOR	MINOR	MAJOR	MINOR
8TH HIGHEST HOUR		600	150	320	90
% OF WARRANT MET				53%	60%

WARRANT #2 - INTERRUPTION OF CONTINOUS TRAFFIC					
70% WARRANT		REQUIRED		EXISTS	
YES	NO	MAJOR	MINOR	MAJOR	MINOR
8TH HIGHEST HOUR		900	75	320	90
% OF WARRANT MET				36%	120%

WARRANT #3 - MINIMUM PEDESTRIAN TRAFFIC					
50% WARRANT		REQUIRED		EXISTS	
YES	NO	PEDS	GAPS	PEDS	GAPS
FOUR HOURS		100	60	69	60
PEAK HOUR		190	60	100	40
% OF WARRANT MET				53%	150%

WARRANT #4 - SCHOOL CROSSING [STUD	YES	NO

WARRANT #5 - PROGRESSIVE MOVEMENT	YES	NO

WARRANT #6 - ACCIDENT EXPERIENCE	YES	NO

WARRANT #7 - SYSTEMS WARRANT	YES	NO

WARRANT #8 - COMBINATION OF WARRANTS				
80 % OF	REQUIRED		EXISTS	
WARRANTS #1 & #2	MAJOR	MINOR	MAJOR	MINOR
WARRANT #1	480	120	320	90
WARRANT #2	720	60	320	90
% OF WARRANT MET			44%	75%

WARRANT #9 - FOUR HOUR VOLUMES				
	MAJOR	MINOR	CURVE NO.	WARRAN
4TH HIGHEST HOUR	420	120	FIGURE	YES
NUMBER OF LANES	1	1	4.7	NO

WARRANT #10 - PEAK HOUR DELAY				
PEAK HOUR:	MINOR LEG		TOTAL ENTERING	
	DELAY	VOLUME	4 LEGS	3 LEGS
REQUIRED VALUES	4	100	800	650
EXISTING VALUES	2.2	130		775

WARRANT #11 - PEAK HOUR VOLUME				
	MAJOR	MINOR	CURVE NO.	WARRAN
PEAK HOUR	560	160	FIGURE	YES
NUMBER OF LANES	2	1	4.5	NO

SUMMARY OF WARRANTS SATISFIED					
WARRANT 1		WARRANT 5		WARRANT 9	
WARRANT 2		WARRANT 6		WARRANT 10	
WARRANT 3		WARRANT 7		WARRANT 11	
WARRANT 4		WARRANT 8		TOTAL =	0

PAGE 2 of 2

SITE

NUMBER

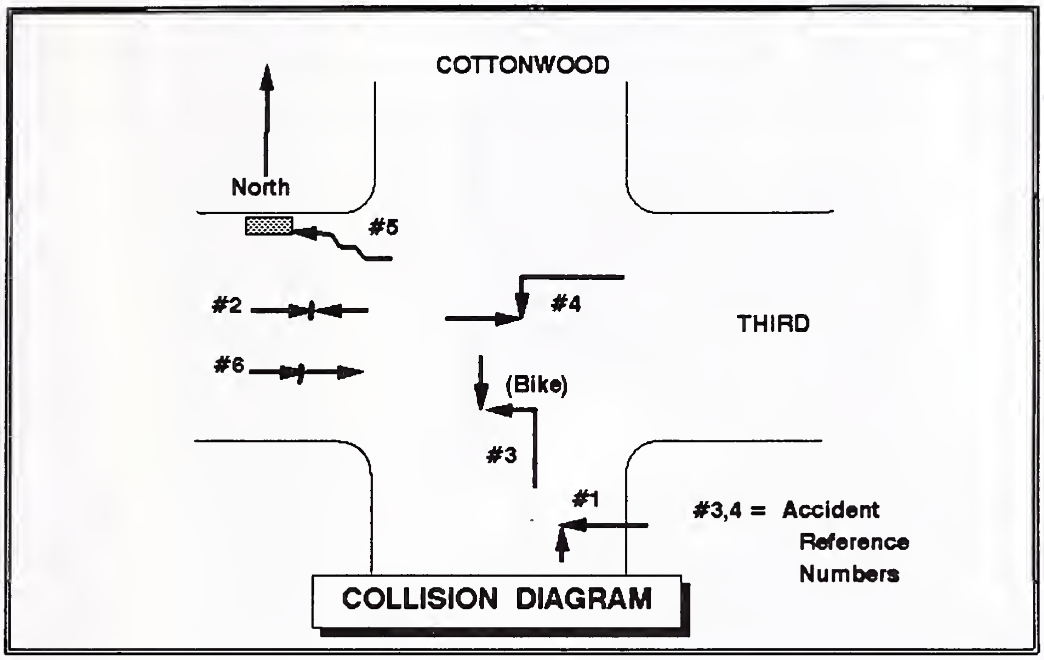
15

COTTONWOOD

and

THIRD

ACCIDENT SUMMARY
COTTONWOOD & THIRD



ACCIDENT KEY

ACC NO.	ACCIDENT TYPE	MO.	DAY	YEAR	TIME	SEVERITY	WEATHER	ROAD	LIGHT
1	ANGLE	3	23	89	1428	PROP DAM	CLEAR	DRY	DAY
2	HEAD ON	1	9	91	1103	PROP DAM	CLEAR	ICY	DAY
3	LEFT TURN	9	18	89	1558	INJURY	CLEAR	WET	DAY
4	LEFT TURN	6	19	91	1441	INJURY	CLEAR	DRY	DAY
5	PARKED VEH	6	28	89	127	PROP DAM	CLEAR	DRY	NITE
6	REAREND	10	23	90	2015	PROP DAM	CLEAR	DRY	NITE

ACCIDENT STATISTICS

NO. ACC.	YEAR		
0	1988	#INJ ACC	3
3	1989	#FAT ACC	0
1	1990	#PDO ACC	3
2	1991	PERSON =	3 *
6	TOTAL	NIGHTIME	20%

* No. of Persons Injured

TYPES	NUMBER	ROAD	
ANGLE	1	DRY	67%
REAR END	1	WET	17%
SIDESWIPE	0	SNOW	0%
LEFT TRN	2	ICE	17%
OTHER	2	OTHER	0%

Looking North

COTTONWOOD

Looking South

Looking East

THIRD

Looking West

TRAFFIC OPERATIONS

Third Street is an east-west arterial and Cottonwood is a local north-south street. Their intersection is in a mostly older residential area of Missoula. The intersection site has office buildings, an apartment building and a parking lot in the corners. Like the Third Street's intersection with Chestnut, this intersection is only one block east of a signalized intersection with Orange Street, a major north -south arterial. As is typical with this situation, drivers on Third tend to drive with most of their attention focused on the signal ahead and over drive the intersection immediately ahead.

The most obvious problem noted at this intersection was the lack of stop sign visibility in the northbound direction because of low growing trees and parked cars. Vehicles park as close to the intersection yellow zones as possible probably because of a parking shortage for the adjacent land use. Stop signs are located too far back from the intersection which limits the length of parking restrictions in front of the signs. Lack of sight distance from the stop positions on Cottonwood to oncoming traffic on Third is also obvious. Turning vehicles at this intersection are quite high in comparison with adjacent intersections. In addition, pedestrian activity, though not significantly high, includes physically handicapped people and some elderly persons.

There were six accidents at this intersection during the reporting period. Two of the accidents were left turn type accidents and one rear end accident was related to a left turn maneuver. The remaining accidents, head-on, angle and parked car were only partially related to the intersections operation.

IMPROVEMENTS

Improving stop sign visibility by trimming trees and relocating the signs closer to the intersection would be beneficial.

Since there is a wide boulevard in this area, it is recommended that the pie shaped areas behind the curb radii be filled in with concrete sidewalk so that crosswalks can be installed in the best locations. Considering the nature of

observed pedestrian crossings and the location of parking lots and buildings, it is recommended that a pedestrian crossing be established on third.

Because of the significant turning movements at this intersection and accident patterns, it is recommended that a left turn bay be marked for westbound traffic. The left turn bay could not be warranted because of capacity, however a transition from the normal two lane, with parking street section at this intersection will tend to refocus driver's attention from the signal ahead to the immediate needs of this intersection. This recommendation will eliminate all parking between Cottonwood and Orange and 100 feet west of the intersection and will vastly improve sight distance.

Long term improvements cannot be foreseen at this location.

COTTONWOOD & THIRD

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	900
SOUTH APP	1200
EAST APP	7100
WEST APP	7000

EXISTING CONTROL:

NONE	
YIELD	
STOP	YES
SIGNAL	

RECOMMENDED CONTROL:

PARKING	YES
YEILD	
STOP	YES
CURB/WALK	YES
MARKING	YES
WARNING	YES
REGULATORY	

ESTIMATED COST:

TOTAL	$4,785
MDoT FUND	$3,520
CITY FUND	$1,265

% ACCIDENT REDUCTION:

	NUMBER	PERCENT
INJ/FTL	1.4	70%
PDO	1.0	25%

BENEFIT/COST RATIO: 7

	INDEX VALUE	SITE RANK
# ACCIDENTS	54	16
ACCIDENT RATE	14	23
SEVERITY	54	7
VOL/CAPACITY	65	11
SIGHT DIST.	100	2
DRIVER EXPECT	63	16
INFO DEFICIENT	79	4
HAZARD INDEX	53.3	16
B/C RATIO	41	14

PRIORITY	49.2	15

SITE

NUMBER

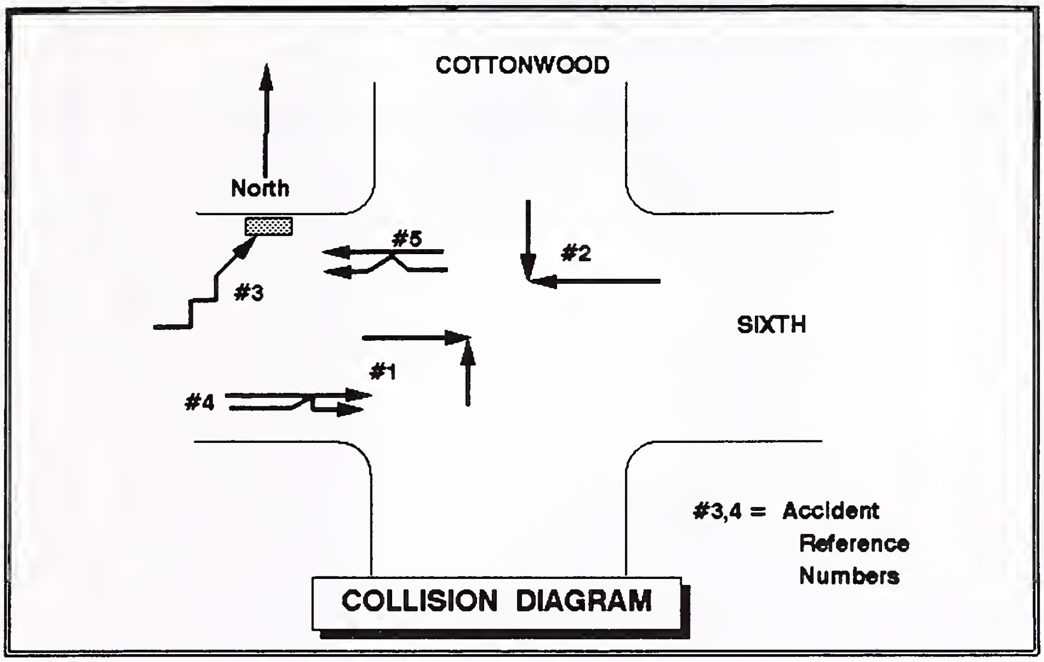
16

COTTONWOOD

and

SIXTH

ACCIDENT SUMMARY
COTTONWOOD & SIXTH



ACC NO.	ACCIDENT TYPE	MO.	DAY	YEAR	TIME	SEVERITY	WEATHER	ROAD	LIGHT
		ACCIDENT KEY							
1	ANGLE	7	28	88	926	INJURY	CLEAR	DRY	DAY
2	ANGLE	6	23	89	834	INJURY	CLEAR	DRY	DAY
3	PARKED VEH	1	26	91	46	PROP DAM	CLEAR	SNOW	NITE
4	SIDE SWIPE	1	29	90	939	PROP DAM	CLEAR	ICY	DAY
5	SIDE SWIPE	6	28	90	2005	PROP DAM	CLEAR	DRY	DAY

ACCIDENT STATISTICS

NO. ACC.	YEAR		
1	1988	#INJ ACC	2
1	1989	#FAT ACC	0
2	1990	#PDO ACC	3
1	1991	PERSON =	2 *
5	TOTAL	NIGHTIME	20%

* No. of Persons Injured

TYPES	NUMBER	ROAD	
ANGLE	2	DRY	60%
REAR END	0	WET	0%
SIDESWIPE	2	SNOW	20%
LEFT TRN	0	ICE	20%
OTHER	1	OTHER	0%

Looking North

Looking South

COTTONWOOD

Looking East

Looking West

SIXTH

TRAFFIC OPERATIONS

Cottonwood is a local north-south street and Sixth is a one-way eastbound collector type street. Sixth is also part of a one-way couplet with Fifth and is part of the current FAU system. The intersection is located on block west of Orange Street, a major arterial. The Orange Street - Sixth intersection is signalized. Sixth's intersection with Cottonwood is typical of intersections adjacent to major signalized intersections in that drivers approaching the signal drive with attention focused on the signal rather than on the immediate intersection. Traffic on Sixth is not significantly high, considering that it is a collector street.

Sight distance at this intersection appears to be good in most cases. Clear vision to the stop signs is maintained and parking demand appears to be low on those approaches. There is no parking on the south side of Sixth and the restricted parking areas on the south side are too short for the speed of traffic on Sixth. Stop signs are located too far from the intersection throat and there is only one sign for each direction of side street traffic indicating that Sixth is a one-way street.

There were 5 accidents at this intersection. Two of them involved drivers going the wrong way on a one-way street. A sideswipe accident on sixth occurred on the intersection approach. An angle accident involved a northbound and eastbound vehicle.

IMPROVEMENTS

Wrong way accidents at this intersection originate at the Orange Street intersection, to the east. An existing no right turn and one-way sign mounted on the northwest signal pole is obscured by a building and a tree. It is not possible to see these signs until a vehicle is already at the intersection. To insure adequate advance warning of the turn restriction, it is recommended that a new no right turn sign be mounted on the signal mast for southbound traffic. Turn restriction signs and additional one-way signs should be installed at the Cottonwood intersection as per MUTCD typical signing schematics. Relocation of the stop signs nearer the intersection and marking of a solid lane line on the intersection approach will help reduce other accidents at this sites.

COTTONWOOD & SIXTH

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	700
SOUTH APP	600
EAST APP	2900
WEST APP	2700

EXISTING CONTROL:

NONE	
YIELD	
STOP	YES
SIGNAL	

RECOMMENDED CONTROL:

PARKING	YES
YEILD	
STOP	YES
CURB	
MARKING	YES
WARNING	
REGULATORY	YES

ESTIMATED COST:

TOTAL	$1,021
MDoT FUND	$931
CITY FUND	$90

% ACCIDENT REDUCTION:

	NUMBER	PERCENT
INJ/FTL	0.8	40%
PDO	1.1	37%

BENEFIT/COST RATIO: 11

	INDEX VALUE	SITE RANK
# ACCIDENTS	50	20
ACCIDENT RATE	25	16
SEVERITY	51	10
VOL/CAPACITY	24	16
SIGHT DIST.	79	16
DRIVER EXPECT	56	22
INFO DEFICIENT	63	12
HAZARD INDEX	46.8	25
B/C RATIO	52	13

PRIORITY	48.5	16

SITE

NUMBER

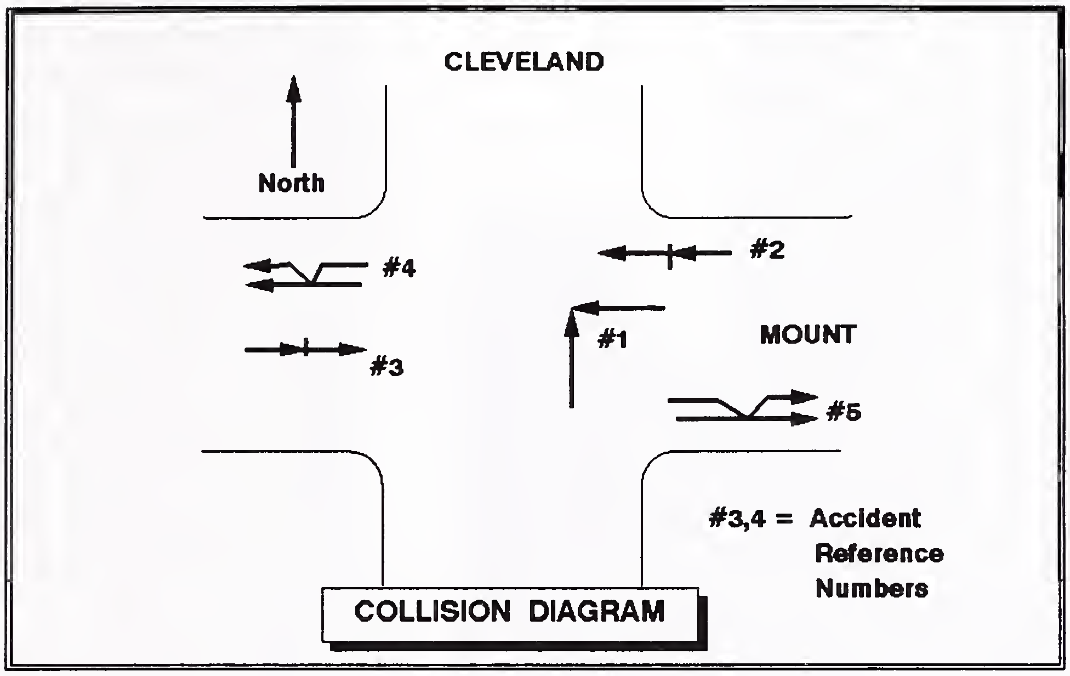
17

MOUNT

and

CLEVELAND

ACCIDENT SUMMARY
MOUNT & CLEVELAND



ACCIDENT KEY

ACC NO.	ACCIDENT TYPE	MO.	DAY	YEAR	TIME	SEVERITY	WEATHER	ROAD	LIGHT
1	ANGLE	2	12	91	1651	PROP DAM	CLEAR	DRY	DAY
2	REAREND	1	13	88	1450	PROP DAM	CLEAR	ICY	DAY
3	REAREND	5	23	88	1515	INJURY	CLEAR	DRY	DAY
4	SIDESWIPE	4	21	88	1923	PROP DAM	RAIN	WET	DAY
5	SIDESWIPE	7	3	90	1457	INJURY	CLEAR	DRY	DAY

ACCIDENT STATISTICS

NO. ACC.	YEAR		
3	1988	#INJ ACC	2
0	1989	#FAT ACC	0
1	1990	#PDO ACC	3
1	1991	PERSON =	2 *
5	TOTAL	NIGHTIME	0%

* No. of Persons Injured

TYPES	NUMBER	ROAD	
ANGLE	1	DRY	60%
REAR END	2	WET	20%
SIDESWIPE	2	SNOW	0%
LEFT TRN	0	ICE	20%
OTHER	0	OTHER	0%

Looking North

CLEVELAND

Looking South

Looking East From Cleveland

MOUNT

Looking West

TRAFFIC OPERATIONS

Cleveland is a local north-south street and Mount is a east-west arterial. Their intersection is located approximately 120' east of the intersection of Mount and Russell, a major signalized intersection. The intersection of Mount and Cleveland would be a T-intersection except that the approach to a convenience store with gas pumps is located directly south of the Cleveland leg and acts as a fourth leg of the intersection.

Traffic volumes on Mount are approximately six times higher than those on Cleveland or the store approach. Turn lanes on Mount for the intersection with Russell, extend part way into the Cleveland intersection. Sight distances would be adequate if this were an isolated intersection. However, turning vehicles from Russell onto Mount cannot be observed from the Cleveland approaches until the vehicles are 120 feet away, which is inadequate for non-conflicting access maneuvers. In addition, traffic queued on Mount waiting for the signal effectively blocks sight distance for certain maneuvers. Sixty percent of every signal cycle during off-peak PM hours develops queues on Mount that completely block access to Cleveland.

There were 5 accidents at this intersection during the reporting period. All of these accidents were related to congestion at this intersection combined with access movements to the side street and approaches.

IMPROVEMENTS

Since there are two many conflicting movements and inadequate sight distance to safely accommodate them, it is recommended that access to and from Cleveland and the convenience store approach be limited. Southbound approach traffic should be restricted to right turns only. Left turns should be prohibited for eastbound traffic. Access to the convenience store can be controlled by pavement markings to restrict their movements. If illegal movements from that access becomes a problem, regulatory signing prohibiting turns from that access would become necessary.

Long term improvements may require modification to the convenience store lot to eliminate the Mount Street access.

MOUNT & CLEVELAND

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	1300
SOUTH APP	1200
EAST APP	8900
WEST APP	9800

EXISTING CONTROL:

NONE	
YIELD	
STOP	YES
SIGNAL	

RECOMMENDED CONTROL:

PARKING	
YEILD	
STOP	YES
CURB	
MARKING	YES
WARNING	
REGULATORY	YES

ESTIMATED COST:

TOTAL	$1,590
MDoT FUND	$1,590
CITY FUND	$0

% ACCIDENT REDUCTION:

	NUMBER	PERCENT
INJ/FTL	0.5	25%
PDO	1.0	33%

BENEFIT/COST RATIO: 6

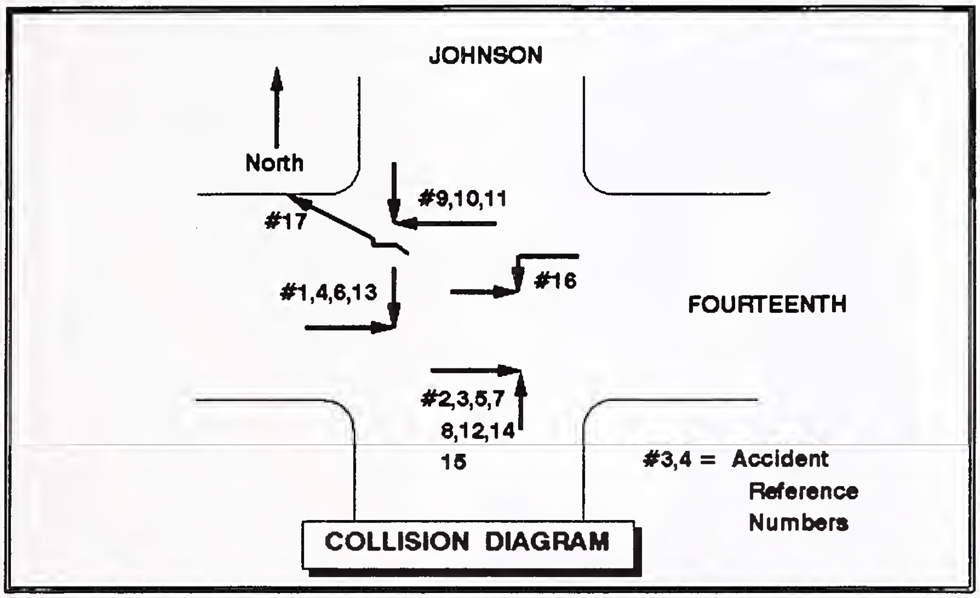
	INDEX VALUE	SITE RANK
# ACCIDENTS	50	23
ACCIDENT RATE	10	25
SEVERITY	51	11
VOL/CAPACITY	83	6
SIGHT DIST.	100	11
DRIVER EXPECT	75	8
INFO DEFICIENT	71	8
HAZARD INDEX	53.6	15
B/C RATIO	38	15

PRIORITY	48.5	17

SITE NUMBER 18

JOHNSON and FOURTEENTH

ACCIDENT SUMMARY
JOHNSON & FOURTEENTH



ACCIDENT KEY

ACC NO.	ACCIDENT TYPE	MO.	DAY	YEAR	TIME	SEVERITY	WEATHER	ROAD	LIGHT
1	ANGLE	5	11	88	1138	PROP DAM	CLEAR	DRY	DAY
2	ANGLE	5	30	89	2122	INJURY	CLEAR	DRY	NITE
3	ANGLE	6	8	89	1635	PROP DAM	CLEAR	DRY	DAY
4	ANGLE	6	24	89	1641	INJURY	CLEAR	DRY	DAY
5	ANGLE	7	18	89	734	PROP DAM	CLEAR	DRY	DAY
6	ANGLE	11	17	89	1436	INJURY	CLEAR	WET	DAY
7	ANGLE	1	1	90	2134	PROP DAM	CLEAR	ICY	NITE
8	ANGLE	2	13	90	1531	PROP DAM	CLEAR	DRY	DAY
9	ANGLE	4	20	90	2054	INJURY	CLEAR	DRY	DAY
10	ANGLE	8	9	90	1601	PROP DAM	CLEAR	DRY	DAY
11	ANGLE	9	16	90	1951	PROP DAM	CLEAR	DRY	DAY
12	ANGLE	10	7	90	103	PROP DAM	CLEAR	DRY	NITE
13	ANGLE	10	24	90	904	INJURY	CLEAR	DRY	DAY
14	ANGLE	2	20	91	1733	PROP DAM	CLEAR	DRY	DAY
15	ANGLE	2	28	91	1442	INJURY	CLEAR	DRY	NITE
16	LEFT TURN	5	27	89	1849	PROP DAM	RAIN	WET	DAY
17	SINGLE VEH	2	21	88	2109	PROP DAM	CLEAR	DRY	NITE

ACCIDENT STATISTICS

NO. ACC.	YEAR			
2	1988	#INJ ACC	6	
6	1989	#FAT ACC	0	
7	1990	#PDO ACC	11	
2	1991	PERSON =	6	*
17	TOTAL	NIGHTIME	29%	

*** No. of Persons Injured**

TYPES	NUMBER	ROAD	
ANGLE	15	DRY	82%
REAR END	0	WET	12%
SIDESWIPE	0	SNOW	0%
LEFT TRN	1	ICE	6%
OTHER	1	OTHER	0%

Looking North

JOHNSON

Looking South

Looking East

FOURTEENTH

Looking West

TRAFFIC OPERATIONS

Johnson Street is a north-south collector street and Fourteenth Street is an east-west arterial which is also a western extension of Mount Avenue. Their intersection is located five blocks west of Russell, mid-way between Reserve Street and Russell. Both Johnson and Fourteenth are fairly narrow streets serving a mixture of residential and commercial land uses within the area.

The existing intersection has three school crossings marked. Stop signs are on the lower volume, Johnson Street. Stop signs are clearly visible on each approach even though the southbound sign is in the shadow of trees. Centerlines are painted on both streets, but partial stop bars are only marked in front of the crosswalks.

The immediate impression of this intersection is one of inefficiency. The intersection in routinely congested and long queues form on Jonhson Street approaches during peaks hours. Heavy turning movement volumes add to capacity problems and create anxious drivers waiting for a chance to clear the intersection. Parking does not appear to be in heavy demand near the intersection and stopped sight distance is usually unrestricted. A final observation would be the abundance of signs on the eastbound approach. In consecutive order, there is a speed limit sign, a truck route sign and a school crossing sign.

There were 15 angle accidents at this intersection during the reporting period. Most of these involved northbound and eastbound vehicles. Six of the angle accidents involved vehicles who had stopped for the sign and the remainder were drivers who failed to stop. Two other accidents involved a left turn from westbound traffic and a single vehicle accident.

IMPROVEMENTS

Because of high traffic volumes and capacity calculations indicating a level-of-service "F" on Johnson Lane, a traffic signal warrant analysis was completed for this intersection and can be found in the back of this section. The warrant analysis indicates that volumes are 80% of the minimum volume warrant #1

and is within 8% of meeting the combination of warrants (#8). Peak hour delay, warrant #10, is definitely met and the accident warrant would be met if other control measures had been attempted in the past. The school crossing warrant was checked based on theoretical gap predictions. A copy of the gap prediction method and delay calculation is included in this section. It was determined that the Fourteenth Street crossings would experience approximately 74% delay for a single line of pedestrians, which is just under a warranting value. Actual counts and observations during school crossing periods may indicate that the delay is either greater or less.

Based on the signal warrant analysis, site conditions and the obvious growth in traffic at this intersection, it is recommended that this intersection be signalized. In addition to basic signalization, it will be necessary to provide left turn bays on Fourteenth to provide maximum safety and efficiency. Two separate capacity analysis calculations were completed for a signalized intersection and are included at the end of this section. The first analysis assumes existing lane control which would operate at a LOS "D" and the second includes the recommended left turn bays which would operate at a LOS "B". Other miscellaneous design considerations for this intersection are illustrated on the improvement plan sketch.

Long term improvements at this intersection may include additional lanes on Johnson Street as traffic volumes increase in the future. In addition, protected left turn phasing may also be required. Mast arm and signal pole locations should account for these future possibilities.

JOHNSON & FOURTEENTH

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	4200
SOUTH APP	4300
EAST APP	10000
WEST APP	9200

EXISTING CONTROL:

NONE	
YIELD	
STOP	YES
SIGNAL	

RECOMMENDED CONTROL:

PARKING	YES
YEILD	
STOP	
WALK	YES
MARKING	YES
SIGNAL	YES
REGULATORY	YES

ESTIMATED COST:

TOTAL	$63,470
MDoT FUND	$6,150
CITY FUND	$57,320

% ACCIDENT REDUCTION:

	NUMBER	PERCENT
INJ/FTL	4.8	80%
PDO	8.0	73%

BENEFIT/COST RATIO: 2

	INDEX VALUE	SITE RANK
# ACCIDENTS	81	2
ACCIDENT RATE	22	18
SEVERITY	50	13
VOL/CAPACITY	100	1
SIGHT DIST.	100	7
DRIVER EXPECT	67	13
INFO DEFICIENT	83	3
HAZARD INDEX	62.7	5
B/C RATIO	18	24

PRIORITY	48.0	18

TRAFFIC SIGNAL WARRANT ANALYSIS
YEAR 1992
JOHNSON & FOURTEENTH

WARRANT #1 - MINIMUM VEHICULAR VOLUME				
70% WARRANT	REQUIRED		EXISTS	
YES NO	MAJOR	MINOR	MAJOR	MINOR
8TH HIGHEST HOUR	500	150	550	120
% OF WARRANT MET			110%	80%

WARRANT #2 - INTERRUPTION OF CONTINOUS TRAFFIC				
70% WARRANT	REQUIRED		EXISTS	
YES NO	MAJOR	MINOR	MAJOR	MINOR
8TH HIGHEST HOUR	750	75	550	120
% OF WARRANT MET			73%	160%

WARRANT #3 - MINIMUM PEDESTRIAN TRAFFIC				
50% WARRANT	REQUIRED		EXISTS	
YES NO	PEDS	GAPS	PEDS	GAPS
FOUR HOURS	100	60	NA	NA
PEAK HOUR	190	60	NA	NA
% OF WARRANT MET			0%	ERR

WARRANT #4 - SCHOOL CROSSING [STUD	YES	POSSIBLE

WARRANT #5 - PROGRESSIVE MOVEMENT	YES	NO

WARRANT #6 - ACCIDENT EXPERIENCE	YES	NO

WARRANT #7 - SYSTEMS WARRANT	YES	NO

WARRANT #8 - COMBINATION OF WARRANTS				
80 % OF	REQUIRED		EXISTS	
WARRANTS #1 & #2	MAJOR	MINOR	MAJOR	MINOR
WARRANT #1	400	120	550	120
WARRANT #2	600	60	550	120
% OF WARRANT MET			92%	100%

WARRANT #9 - FOUR HOUR VOLUMES				
	MAJOR	MINOR	CURVE NO.	WARRAN
4TH HIGHEST HOUR	670	150	FIGURE	YES
NUMBER OF LANES	1	1	4.7	NO

WARRANT #10 - PEAK HOUR DELAY				
PEAK HOUR:	MINOR LEG		TOTAL ENTERING	
	DELAY	VOLUME	4 LEGS	3 LEGS
REQUIRED VALUES	4	100	800	650
EXISTING VALUES	5.5	275	1500	

WARRANT #11 - PEAK HOUR VOLUME				
	MAJOR	MINOR	CURVE NO.	WARRAN
PEAK HOUR	1030	155	FIGURE	YES
NUMBER OF LANES	1	1	4.5	NO

SUMMARY OF WARRANTS SATISFIED					
WARRANT 1		WARRANT 5		WARRANT 9	
WARRANT 2		WARRANT 6		WARRANT 10	YES
WARRANT 3		WARRANT 7		WARRANT 11	
WARRANT 4	POSSIBLE	WARRANT 8		TOTAL =	1+

PAGE 2 of 2

GAP PREDICTION PROGRAM R. MARVIN 11/24/89

NEGATIVE EXPONENTIAL DISTRIBUTION

FORMULA: PROBABILITY OF GAP > CRITICAL GAP = e ^ -u x t

WHERE: e = NATURAL EXPONENT = 2.71828

u = RATE OF ARRIVAL = VOLUME/3600

t = CRITICAL GAP

PROBLEM CALCULATION:

LOCATION: JOHNSON & FOURTEEN DATE OF ANALYSIS: 8/30/92

TWO WAY VOLUME = 660

CRITICAL GAP	% P(G>t)	NO. GAPS >= t	TOT GAP TIME	37' WIDE GAP TIME >CRIT(t)
0	100.0%	660		
1	83.2%	549	111	
2	69.3%	457	184	
3	57.7%	381	230	
4	48.0%	317	255	
5	40.0%	264	266	
6	33.3%	220	265	
7	27.7%	183	258	
8	23.1%	152	245	
9	19.2%	127	230	
10	16.0%	106	212	
11	13.3%	88	194	
12	11.1%	73	177	
13	9.2%	61	159	
14	7.7%	51	143	
15	6.4%	42	127	127
16	5.3%	35	113	113
17	4.4%	29	100	100
18	3.7%	24	88	88
19	3.1%	20	77	77
20	2.6%	17	68	68
21	2.1%	14	59	59
22	1.8%	12	52	52
23	1.5%	10	45	45
24	1.2%	8	39	39
25	1.0%	7	34	34
26	0.9%	6	29	29
27	0.7%	5	25	25
28	0.6%	4	22	22
29	0.5%	3	19	19
30	0.4%	3	16	16
40	0.1%	0	91	91
50	0.0%	0	18	18
TOTALS =			3952	1024

DELAY = (T-t)/T EXIST = 74.1%

HCM: SIGNALIZED INTERSECTION SUMMARY

Marvin & Associates

Streets: (E-W) FOURTEENTH (N-S) JOHNSON

Analyst: R MARVIN

File Name:

Area Type: Other

8-30-92 PEAK PM

Comment: ONE LANE APPROACH CONFIGURE

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	>	1	<	>	1	<	>	1	<	>	1	<
Volumes	45	410	25	65	530	45	15	200	95	40	130	60
Lane Width		12.0			12.0			12.0			12.0	
RTOR Vols			5			5			5			5

Signal Operations

Phase combination	1	2	3	4		5	6	7	8
EB Left	*				NB Left	*			
Thru	*				Thru	*			
Right	*				Right	*			
Peds	*				Peds	*			
WB Left	*				SB Left	*			
Thru	*				Thru	*			
Right	*				Right	*			
Peds	*				Peds	*			
NB Right	*				EB Right	*			
SB Right	*				WB Right	*			
Green	50P				Green	22A			
Yellow/A-R	4				Yellow/A-R	4			
Lost Time	3.0				Lost Time	3.0			

Cycle Length: 80 secs Phase combination order: #1 #5

Intersection Performance Summary

	Lane Group: Mvmts	Cap	Adj Sat Flow	v/c Ratio	g/c Ratio	Delay	LOS	Approach: Delay	LOS
EB	LTR	1097	699	0.80	0.64	12.6	B	12.6	B
WB	LTR	1198	764	0.98	0.64	31.0	D	31.0	D
NB	LTR	1302	374	0.96	0.29	47.7	E	47.7	E
SB	LTR	993	285	0.93	0.29	46.0	E	46.0	E

Intersection Delay = 30.8 (sec/veh) Intersection LOS = D

HCM: SIGNALIZED INTERSECTION SUMMARY

Marvin & Associates

Streets: (E-W) FOURTEENTH (N-S) JOHNSON
Analyst: R MARVIN
File Name:
Area Type: Other
8-30-92 PEAK PM
Comment: LEFT TURN P/P ON FOURTEENTH

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	1	1	<	1	1	<	>	1	<	>	1	<
Volumes	45	410	25	65	530	45	15	200	95	40	130	60
Lane Width	12.0	12.0		12.0	12.0			12.0			12.0	
RTOR Vols			5			5			5			5

Signal Operations

Phase combination	1	2	3	4
EB Left	*			
Thru	*			
Right	*			
Peds	*			
WB Left	*			
Thru	*			
Right	*			
Peds	*			
NB Right	*			
SB Right	*			
Green	48A			
Yellow/A-R	4			
Lost Time	3.0			

	5	6	7	8
NB Left	*			
Thru	*			
Right	*			
Peds	*			
SB Left	*			
Thru	*			
Right	*			
Peds	*			
EB Right	*			
WB Right	*			
Green	30A			
Yellow/A-R	4			
Lost Time	3.0			

Cycle Length: 86 secs Phase combination order: #1 #5

Intersection Performance Summary

	Lane Mvmts	Group: Cap	Adj Sat Flow	v/c Ratio	g/c Ratio	Delay	LOS	Approach: Delay	LOS
EB	L	543	309	0.17	0.57	6.7	B	7.4	B
	TR	1769	1008	0.50	0.57	7.5	B		
WB	L	771	439	0.17	0.57	6.7	B	9.1	B
	TR	1763	1004	0.67	0.57	9.3	B		
NB	LTR	1532	552	0.65	0.36	16.5	C	16.5	C
SB	LTR	1236	446	0.59	0.36	15.8	C	15.8	C

Intersection Delay = 10.9 (sec/veh) Intersection LOS = B

SITE

NUMBER

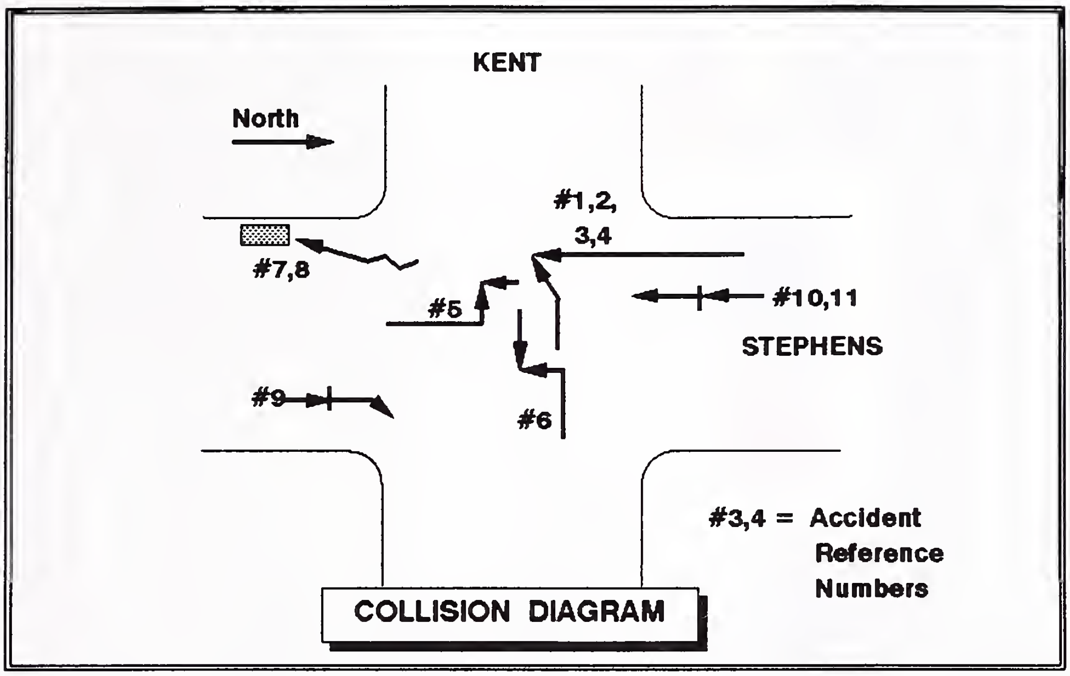
19

STEPHENS

and

KENT

ACCIDENT SUMMARY
STEPHANS & KENT



ACCIDENT KEY

ACC NO.	ACCIDENT TYPE	MO.	DAY	YEAR	TIME	SEVERITY	WEATHER	ROAD	LIGHT
1	ANGLE	3	14	91	1257	PROP DAM	CLEAR	DRY	DAY
2	ANGLE	8	29	91	1011	PROP DAM	CLEAR	DRY	DAY
3	ANGLE	10	19	91	1140	PROP DAM	CLEAR	DRY	DAY
4	ANGLE	11	26	91	1146	PROP DAM	CLEAR	WET	DAY
5	LEFT TURN	9	17	88	1608	PROP DAM	RAIN	WET	DAY
6	LEFT TURN	10	17	88	1753	PROP DAM	CLEAR	DRY	DAY
7	PARKED VEH	11	2	90	1856	PROP DAM	CLEAR	DRY	NITE
8	PARKED VEH	12	17	90	1149	PROP DAM	SNOW	ICY	DAY
9	REAREND	3	1	91	1048	PROP DAM	SNOW	ICY	DAY
10	REAREND	9	4	91	1625	PROP DAM	CLEAR	DRY	DAY
11	REAREND	10	10	91	1332	INJURY	CLEAR	DRY	DAY

ACCIDENT STATISTICS

NO. ACC.	YEAR		
2	1988	#INJ ACC	1
0	1989	#FAT ACC	0
2	1990	#PDO ACC	10
7	1991	PERSON =	1 *
11	TOTAL	NIGHTIME	9%

* No. of Persons Injured

TYPES	NUMBER	ROAD	
ANGLE	4	DRY	64%
REAR END	3	WET	18%
SIDESWIPE	0	SNOW	0%
LEFT TRN	2	ICE	18%
OTHER	2	OTHER	0%

Looking North From Kent

STEPHENS

Looking South

Looking East From Brooks

KENT

Looking West

TRAFFIC OPERATIONS

Stephens is a north-south arterial and Kent is a local east-west street. Their intersection is located approximately 180 feet south of the Stephens - Brooks intersection, which is signalized. An initial reaction to this intersection would be surprise. The intersection is so close to the Brooks intersection that it appears to be one intersection with a building in the middle of a traffic island. The building, which is located in the northwest corner of the intersection, is only 5 feet behind the curb and presents a significant sight restriction for eastbound vehicles. Fortunately traffic volumes on that approach are very low. Traffic volumes on the remaining approaches are significantly higher. Turning movements at this intersection are a large percentage of total entering traffic.

The most significant factor noted during operational observations, was the immediate origin and destination of a large percentage of the intersections traffic. Exactly 90% of all traffic on the east approach to this intersection enters and exits the curb approach for the Albertson's parking lot. This curb cut is located at the end of the radius in the northeast corner of the intersection. This approach is located within the legal no parking zone and serves semi tractor-trailer traffic as well as customer access. Albertson's loading docks are located immediately inside the property next to this approach.

The most surprising aspect of this intersection is the fact that there were only eleven accidents during the reporting period. Four of those were angle accidents involving westbound left turning vehicles being hit by right hand "sneakers", which are vehicles that pass to the right of a queue of vehicles waiting for a southbound left turning vehicle. Two rearend accidents were related to southbound left turns and one rearend was related to a northbound right turning driver being cutoff by a southbound left turn. Two other left turn accidents were on other directional approaches. Two accidents involved parked vehicles being struck at a location where they shouldn't have been parked.

IMPROVEMENTS

There are a number of alternative solutions to the accident problems being experienced at this location. The most obvious solution would also be a part of the long term recommendation to close or relocate the Albertson's store rear approach. Even if this intersection had no other problems and the approach only served transport vehicles, its location would cause numerous traffic conflicts. Even though this solution is obvious, it is not simple. Apparently a great deal of shopping center traffic has been cut off from a more desirable access on Brooks by channelization and turn prohibition, otherwise no one would want to use this access. Completely closing the approach may shift traffic to another less desirable access point and transport vehicles may have no other desirable alternative than this access.

Existing traffic volumes at this intersection would meet minimum volume warrants for signalization. This intersection could conceivably be signalized and controlled by the Brooks Street intersection controller. Proper phasing and overlap timing could eliminate most of the intersection conflicts between turning and thru vehicles. However, proper coordination with overlap timing may steal some green time from Brooks, which is not exactly desirable. In addition, costs of a new signal installation would be upwards of $ 60,000 for a problem which is essentially related to a private business.

The recommended short term improvement would be installation of a traffic island on Stephens, through the intersection. This would make left turns at the intersection impossible. Several turn and thru movements would be prohibited, which would result in the elimination of the most serious conflict points at this intersection. Drivers who access the Albertson lot from the southbound left turn movement would be required to replan their trip to the shopping center. Vehicles would still be able to use the rear approach to exit the shopping center. Pavement markings on the Kent Street approaches would aid in proper vehicle alignment at the intersection approaches.

Long term improvements would consist of a complete traffic plan for the shopping area along Brooks. The plan should consider modifications to internal lot circulation and access with the purpose of closing the undesirable approach on Kent Street and on other similar streets. The study and plan should be undertaken with complete cooperation of the city and the businesses.

STEPHENS & KENT

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	8100
SOUTH APP	8300
EAST APP	5400
WEST APP	900

EXISTING CONTROL:

NONE	
YIELD	
STOP	YES
SIGNAL	

RECOMMENDED CONTROL:

PARKING	
YEILD	
STOP	YES
CURB	YES
MARKING	YES
WARNING	
REGULATORY	YES

ESTIMATED COST:

TOTAL	$8980
MDoT FUND	$2310
CITY FUND	$6670

% ACCIDENT REDUCTION:

	NUMBER	PERCENT
INJ/FTL	0.5	50%
PDO	3.8	38%

BENEFIT/COST RATIO: 3

	INDEX VALUE	SITE RANK
# ACCIDENTS	69	6
ACCIDENT RATE	18	20
SEVERITY	39	24
VOL/CAPACITY	100	2
SIGHT DIST.	100	13
DRIVER EXPECT	83	4
INFO DEFICIENT	58	17
HAZARD INDEX	57.2	9
B/C RATIO	21	23

PRIORITY	45.3	19

SITE

NUMBER

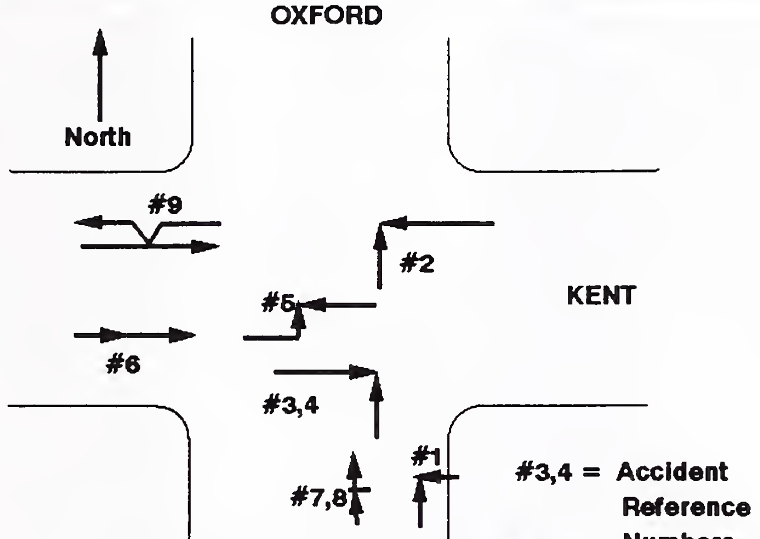
20

KENT

and

OXFORD

ACCIDENT SUMMARY
KENT & OXFORD



COLLISION DIAGRAM

ACCIDENT KEY

ACC NO.	ACCIDENT TYPE	MO.	DAY	YEAR	TIME	SEVERITY	WEATHER	ROAD	LIGHT
1	ANGLE	3	5	88	1146	PROP DAM	CLEAR	DRY	DAY
2	ANGLE	3	1	89	1655	PROP DAM	SNOW	ICY	DAY
3	ANGLE	1	25	90	1208	INJURY	CLEAR	DRY	DAY
4	ANGLE	8	6	91	934	INJURY	CLEAR	DRY	DAY
5	LEFT TURN	7	9	91	1355	PROP DAM	CLEAR	DRY	DAY
6	REAREND	4	18	90	1545	PROP DAM	CLEAR	DRY	DAY
7	REAREND	8	10	90	1212	INJURY	CLEAR	DRY	DAY
8	REAREND	12	18	90	838	PROP DAM	CLEAR	ICY	DAY
9	SIDESWIPE	5	22	91	1940	PROP DAM	CLEAR	DRY	DAY

ACCIDENT STATISTICS

NO. ACC.	YEAR		
1	1988	#INJ ACC	3
1	1989	#FAT ACC	0
4	1990	#PDO ACC	6
3	1991	PERSON =	3 *
9	TOTAL	NIGHTIME	0%

*** No. of Persons Injured**

TYPES	NUMBER	ROAD	
ANGLE	4	DRY	78%
REAR END	3	WET	0%
SIDESWIPE	1	SNOW	0%
LEFT TRN	1	ICE	22%
OTHER	0	OTHER	0%

Looking North

Looking South

OXFORD

Looking East

Looking West

KENT

TRAFFIC OPERATIONS

Kent is a local east-west street and Oxford is a local north-south street. Their intersection is located approximately one block west of Brooks. Both streets intersect Brooks at an angle.

Initial impressions of this intersection would lead one to believe that you had entered a shopping center parking lot by mistake. The only legs of this intersection with defined street limits are on the east and north approaches. All other approaches to this intersection appear to be part of the parking lot. Stop signs are mounted on the Oxford Street approaches and are visible unless a camper or RV parks within the line of sight. Sight distance from the stopped position is also impaired by parked cars, especially in the northwest corner where there is perpendicular parking allowed up to the curb radius.

Turning movement volumes show extremely high percentages of left and right turns on all approaches. When combined with lack of access control, numerous conflict movements can be seen. A drive-up mailbox and postal sub-station exists just east of the intersection which adds considerable traffic to this area. In addition, there are a large number of pedestrian crossings in the area, most of which occur near the intersection.

There were nine accidents at this intersection. Four of them were angle accidents, one left turn, three rearend accidents and one sideswipe. Most of them occurred during high traffic volume hours of the day.

IMPROVEMENTS

Primary consideration toward improving this intersection should be directed to making it appear to be an intersection of two streets. A curbed island in the south west corner and a sidewalk bulb island in the northwest corner should be installed to control vehicle movements through the intersection and to provide minimum sight distance from the stop signs. Double yellow centerlines, stop bars and pedestrian crossing should be added to all legs of the intersection to define proper vehicles paths and stop conditions. Stop signs should be replaced with over sized 36" signs and located at a point more

visible to approaching traffic. An approach located in the southeast corner of the intersection should be closed because its location would interfere with intersection operations. This approach may be moved to the south along Oxford, if possible.

Long term improvements at this location should consider complete access control to the adjacent businesses. It may even be desirable to close Kent Street west of the intersection to eliminate conflict movements. The shopping center parking lot could be restructured to provide a main access point between Kent and Brooks somewhere at mid-block. This would require intense planning and full cooperation between the shopping center and the city. In this case benefits would extend beyond reduced accidents by reducing vehicle delay and providing more convenient access to the shopping center and more parking available.

KENT & OXFORD

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	3200
SOUTH APP	3000
EAST APP	5900
WEST APP	6000

EXISTING CONTROL:

NONE	
YIELD	
STOP	YES
SIGNAL	

RECOMMENDED CONTROL:

PARKING	YES
YEILD	
STOP	YES
CURB/WALK	YES
MARKING	YES
SIGNAL	
REGULATORY	

ESTIMATED COST:

TOTAL	$7,725
MDoT FUND	$2,235
CITY FUND	$5,490

% ACCIDENT REDUCTION:

	NUMBER	PERCENT
INJ/FTL	1.0	33%
PDO	1.0	17%

BENEFIT/COST RATIO: 3

	INDEX VALUE	SITE RANK
# ACCIDENTS	64	8
ACCIDENT RATE	18	19
SEVERITY	49	14
VOL/CAPACITY	100	3
SIGHT DIST.	54	20
DRIVER EXPECT	83	2
INFO DEFICIENT	67	11
HAZARD INDEX	56	13
B/C RATIO	22	22

PRIORITY	44.8	20

SITE

NUMBER

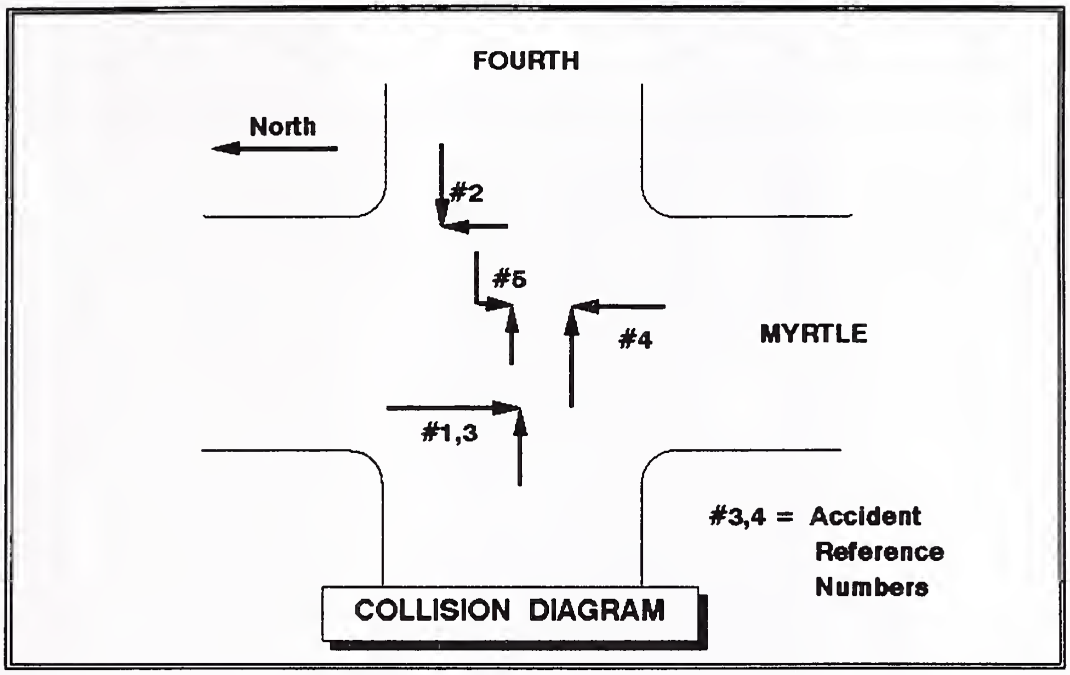
21

MYRTLE

and

FOURTH

ACCIDENT SUMMARY
MYRTLE & FOURTH



ACCIDENT KEY

ACC NO.	ACCIDENT TYPE	MO.	DAY	YEAR	TIME	SEVERITY	WEATHER	ROAD	LIGHT
1	ANGLE	8	9	88	1509	INJURY	CLEAR	DRY	DAY
2	ANGLE	8	19	88	1410	PROP DAM	CLEAR	DRY	DAY
3	ANGLE	6	26	89	1349	PROP DAM	CLEAR	DRY	DAY
4	ANGLE	6	6	91	1123	PROP DAM	CLEAR	DRY	DAY
5	LEFT TURN	8	17	89	1713	PROP DAM	CLEAR	DRY	DAY

ACCIDENT STATISTICS

NO. ACC.	YEAR		
2	1988	#INJ ACC	1
2	1989	#FAT ACC	0
0	1990	#PDO ACC	4
1	1991	PERSON =	1 *
5	TOTAL	NIGHTIME	0%

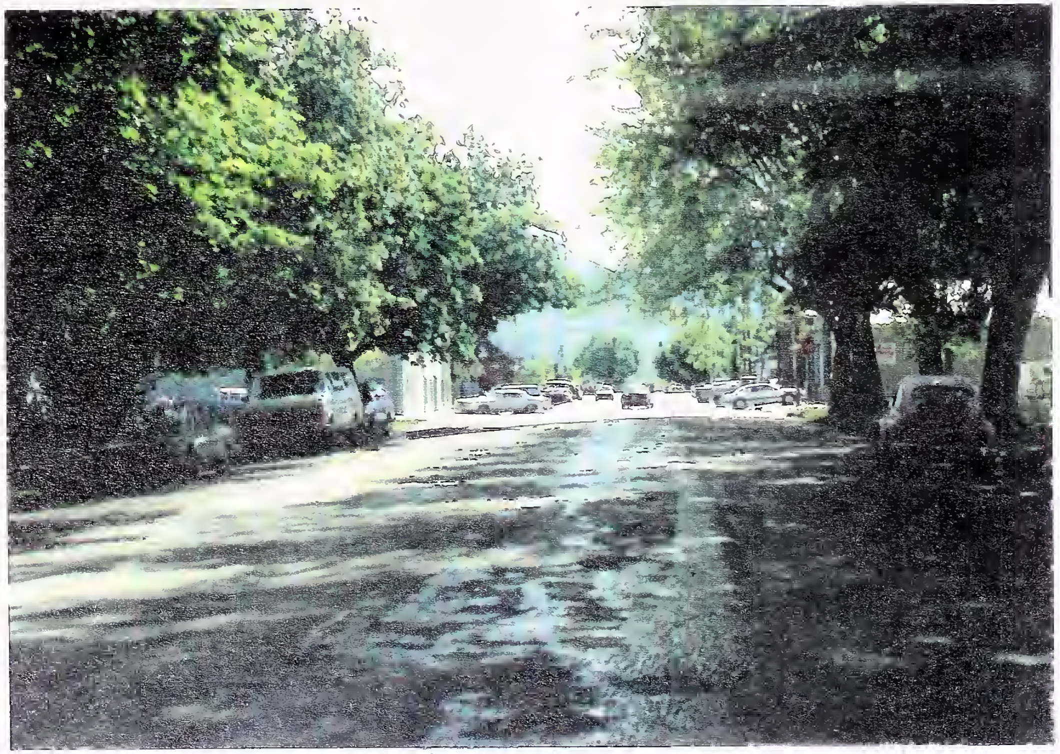
* No. of Persons Injured

TYPES	NUMBER	ROAD	
ANGLE	4	DRY	100%
REAR END	0	WET	0%
SIDESWIPE	0	SNOW	0%
LEFT TRN	1	ICE	0%
OTHER	0	OTHER	0%


Looking North

MYRTLE

Looking South


Looking East

FOURTH

Looking West

TRAFFIC OPERATIONS

Myrtle is a local north-south street and Fourth is a local east-west street. Their intersection is located approximately one block west of Higgins, a major north-south arterial. The intersection carries relatively low traffic volumes. A large percentage of the traffic is circulation traffic from businesses on the east side of the intersection on Fourth.

An initial and lasting impression of this intersection is that the stop signs are on the wrong street. This is probably because the intersection on either side requires a stop on Myrtle, while the residential area west of the intersection consists largely of uncontrolled intersections. The line of sight to the stops signs is impeded by parked vehicles. Angle parking on the east approach provides the greatest sight obstruction. The westbound stop sign is damaged and faded. Angle parking on Myrtle also restricts the required line of sight from the stopped position.

Of the five accidents at this site, four of them were angle accidents which are basically split between the approaches. A left turn accident involved an eastbound and a westbound left turn caused by a failure to stop at the stop sign.

IMPROVEMENTS

Recommended improvements at this location deal with improving sight distance for all approaches. Some consideration was given to reversing the direction of stop control, but approach volumes are approximately equal and more extensive work may be required to effect this change.

It is recommended that the intersection corner be modified to provide curb bulb and sidewalk islands. The following are important reasons why the curb bulbs are being recommended:

1. Curb bulbs at intersections provide a physical barrier which insures that vehicles will not park in the required line of sight. Experience has shown that painted and signed angle parking restrictions at intersections are frequently violated.

2. Curb bulbs allow side street vehicles to stop closer to the main street traffic lanes which reduces parking setbacks required for minimum sight distance on the main street. In the case of angle parking, where the number of parking spaces is critical, curb bulbs can save a substantial number of spaces.

3. Curb bulbs provide pedestrians a clear line of sight and a protected refuge while waiting for a traffic gap. The bulb sidewalk section also elevates pedestrians at a point where approaching traffic can see them.

4. Curb bulbs reduce the distance to cross the street and therefore, pedestrian crossing time is reduced significantly. Thus, the number of acceptable traffic gaps is increased.

5. Since the number of acceptable pedestrian crossing gaps are increased with curb bulbs, installation of traffic signals may be delayed if the signals are based on pedestrian crossing warrants.

6. Narrower street sections between the curb bulbs reduce pavement width and thus, better define the proper vehicles paths. This tightens control and reduces the amount of area that vehicles have to make errant lane changes and turns from the wrong lane.

7. Curb bulbs allow a protected area in which stop signs and other traffic control devices can be located for maximum visibility.

8. Curb bulbs provide instant visual recognition of the exact intersection location for drivers, because they protrude into the street beyond the mid-block curbline. This recognition provides drivers with advanced information regarding vehicle positioning and navigation.

9. Curb bulbs provide an area for low growth landscaping which improves the aesthetic appearance of the intersection area and surrounding land use. The landscape area also encourages pedestrians to cross at the intersection throat rather than at locations prior to the intersection.

Critical to changing the drivers perception of this intersection is new centerline, crosswalk and stop bar markings which will reinforce the stop control condition and provide guidance to drivers with regard to vehicle alignment.

Long term improvements at this intersection would include modified parking.

MYRTLE & FOURTH

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	1400
SOUTH APP	1000
EAST APP	2100
WEST APP	1100

EXISTING CONTROL:

NONE	
YIELD	
STOP	YES
SIGNAL	

RECOMMENDED CONTROL:

PARKING	YES
YEILD	
STOP	YES
CURB/WALK	YES
MARKING	YES
SIGNAL	
REGULATORY	

ESTIMATED COST:

TOTAL	$6,670
MDoT FUND	$1,305
CITY FUND	$5,365

% ACCIDENT REDUCTION:

	NUMBER	PERCENT
INJ/FTL	0.0	60%
PDO	1.9	48%

BENEFIT/COST RATIO: 3

	INDEX VALUE	SITE RANK
# ACCIDENTS	50	24
ACCIDENT RATE	30	12
SEVERITY	44	20
VOL/CAPACITY	41	15
SIGHT DIST.	100	10
DRIVER EXPECT	83	5
INFO DEFICIENT	58	15
HAZARD INDEX	52.9	18
B/C RATIO	23	20

PRIORITY	43	21

SITE

NUMBER

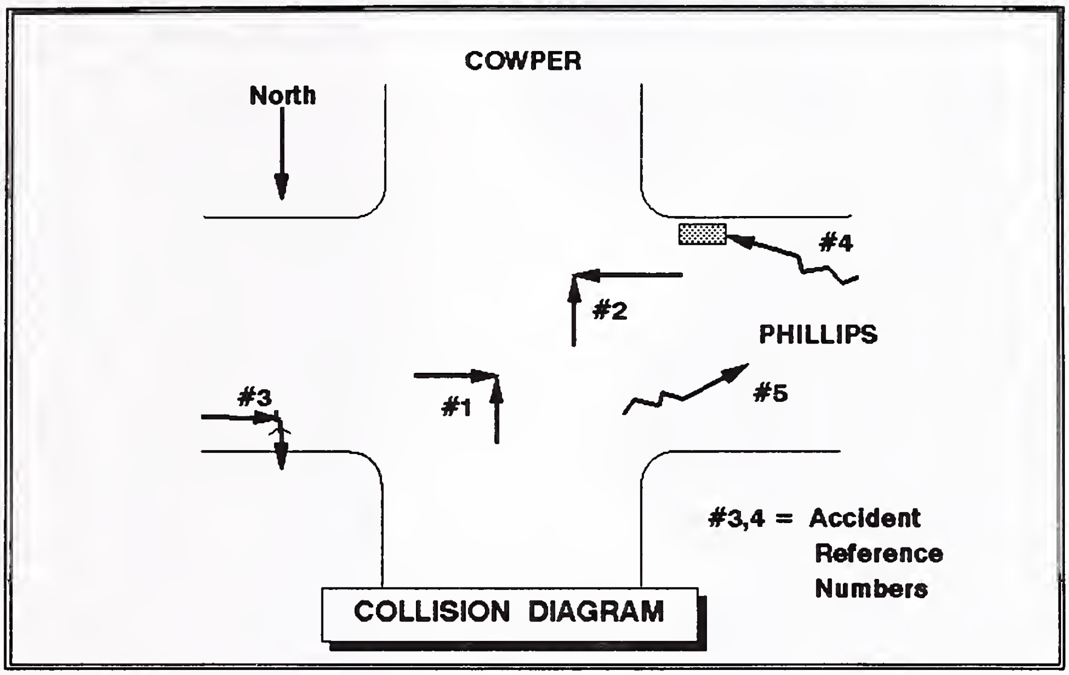
22

PHILLIPS

and

COWPER

ACCIDENT SUMMARY
PHILLIPS & COWPER



ACCIDENT KEY

ACC NO.	ACCIDENT TYPE	MO.	DAY	YEAR	TIME	SEVERITY	WEATHER	ROAD	LIGHT
1	ANGLE	3	21	88	1243	INJURY	CLEAR	DRY	DAY
2	ANGLE	6	6	90	2050	PROP DAM	RAIN	WET	DAY
3	BACKING	8	20	90	1644	PROP DAM	CLEAR	DRY	DAY
4	PARKED VEH	2	29	88	452	INJURY	CLEAR	DRY	NITE
5	SINGLE VEH	1	1	91	2321	PROP DAM	CLEAR	ICY	NITE

ACCIDENT STATISTICS

NO. ACC.	YEAR		
2	1988	#INJ ACC	1
0	1989	#FAT ACC	0
2	1990	#PDO ACC	4
1	1991	PERSON =	1 *
5	TOTAL	NIGHTIME	40%

*** No. of Persons Injured**

TYPES	NUMBER	ROAD	
ANGLE	2	DRY	60%
REAR END	0	WET	20%
SIDESWIPE	0	SNOW	0%
LEFT TRN	0	ICE	20%
OTHER	3	OTHER	0%

Looking North

Looking South

COWPER

Looking East

Looking West

PHILLIPS

TRAFFIC OPERATIONS

Phillips is an east-west collector street and Cowper is a local north-south street. Phillips has traffic volumes approximately ten times that of Cowper. The only sight distance restrictions at this intersection involve a vertical curve on Cowper, midblock, south of the intersection and the presence of parking on Phillips. The vertical curve is not severe enough to block line of sight to the stop sign, but it is sufficient to create partial blockage when vehicles are parked within 30 feet of the sign. Cars parked along Phillips are sparse, but they crowd the corner and are difficult to see past. Both of the stop signs at this intersection area damaged and one is faded. Pavement markings consist of a dashed yellow centerline on Phillips.

There were 5 accidents at this study site during the reporting period. Two of these were angle accidents involving northbound vehicles. Two accidents involved single vehicles, one hitting a parked car. Those two accidents along with the backing accidents have little to do with the stop control, but may be related to parking and other conditions at the site.

IMPROVEMENTS

It is recommended that the existing stop signs be replaced with over size 36" signs to emphasize the stop condition. Because of the vertical curve, a stop ahead sign should be placed for northbound traffic on Cowper. Parking signs and curb markings should be installed on all legs to keep the intersection clear of distractions and sight restrictions. In addition, the dashed centerline striping is inappropriate for urban conditions. No passing zones must be marked for intersections and they are not spaced far enough apart to allow passing in between them.

No long term improvements can be recommended at this site.

PHILLIPS & COWPER

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	250
SOUTH APP	200
EAST APP	2600
WEST APP	2500

EXISTING CONTROL:

NONE	
YIELD	
STOP	YES
SIGNAL	

RECOMMENDED CONTROL:

PARKING	YES
YEILD	
STOP	YES
WALK	
MARKING	YES
WARNING	YES
REGULATORY	

ESTIMATED COST:

TOTAL	$1,200
MDoT FUND	$1,160
CITY FUND	$40

% ACCIDENT REDUCTION:

	NUMBER	PERCENT
INJ/FTL	0.7	35%
PDO	0.7	23%

BENEFIT/COST RATIO: 5

	INDEX VALUE	SITE RANK
# ACCIDENTS	50	25
ACCIDENT RATE	29	14
SEVERITY	51	12
VOL/CAPACITY	45	14
SIGHT DIST.	42	21
DRIVER EXPECT	58	18
INFO DEFICIENT	67	10
HAZARD INDEX	47.4	24
B/C RATIO	34	16

PRIORITY	43.0	22

SITE

NUMBER

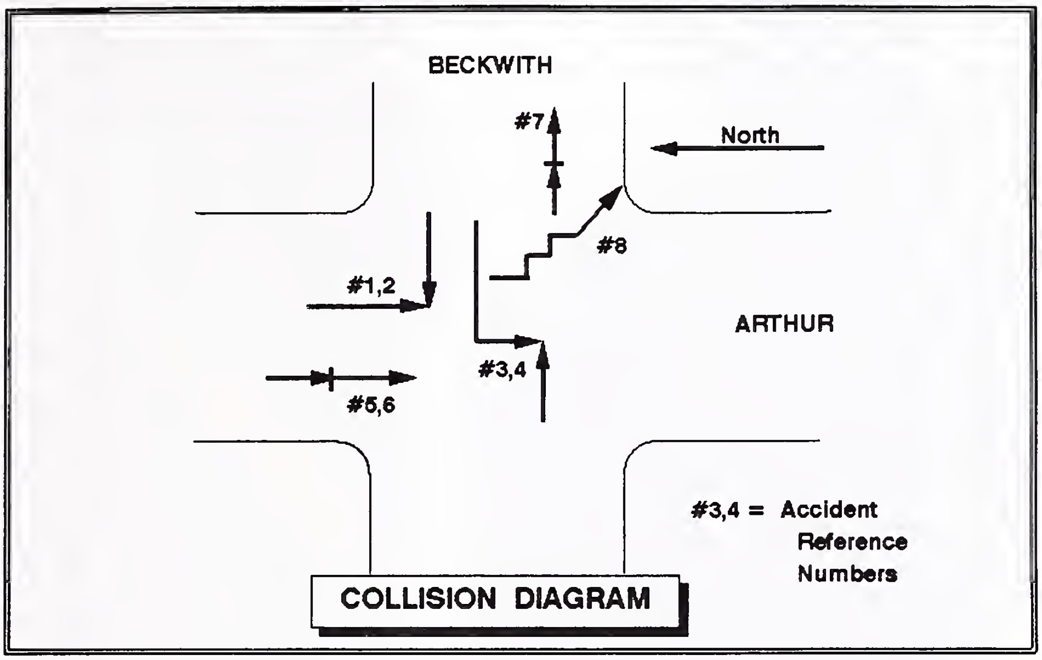
23

ARTHUR

and

BECKWITH

ACCIDENT SUMMARY
ARTHUR & BECKWITH



ACC NO.	ACCIDENT TYPE	ACCIDENT KEY MO.	DAY	YEAR	TIME	SEVERITY	WEATHER	ROAD	LIGHT
1	ANGLE	2	11	88	2153	INJURY	CLEAR	DRY	NITE
2	ANGLE	11	15	90	1458	PROP DAM	CLEAR	DRY	DAY
3	LEFT TURN	7	21	88	850	INJURY	CLEAR	DRY	DAY
4	LEFT TURN	10	12	90	1411	PROP DAM	RAIN	WET	DAY
5	REAREND	4	6	90	1416	INJURY	CLEAR	DRY	DAY
6	REAREND	6	13	91	933	PROP DAM	CLEAR	DRY	DAY
7	REAREND	11	6	91	810	PROP DAM	CLEAR	ICY	DAY
8	SINGLE VEH	2	14	89	1618	PROP DAM	SNOW	SNOW	DAY

ACCIDENT STATISTICS

NO. ACC.	YEAR		
2	1988	#INJ ACC	3
1	1989	#FAT ACC	0
3	1990	#PDO ACC	5
2	1991	PERSON =	4 *
8	TOTAL	NIGHTIME	13%

* No. of Persons Injured

TYPES	NUMBER	ROAD	
ANGLE	2	DRY	75%
REAR END	3	WET	13%
SIDESWIPE	0	SNOW	0%
LEFT TRN	2	ICE	13%
OTHER	1	OTHER	0%

Looking North

Looking South

ARTHUR

Looking East

Looking West

BECKWITH

TRAFFIC OPERATIONS

Arthur Street is a north-south collector street and Beckwith is an east-west collector street. Their intersection is located on the southern fringe of the University of Montana campus. The east leg of the intersection provides access to a university loop road and several large parking lots. Since the university was not in full session during the initial traffic observation and counting periods, another count was taken during the peak AM period in early fall. Very high peak traffic demands were observed at that time.

Physical conditions at the site indicate standard traffic control features at this signalized intersection. The only problems noted were trees obscuring vision of the eastbound traffic signal indications on the advanced approach. Signal heads on the mast arm are 12"x8"x8" and on the poles they are 8"x8"x8". Amber intervals on both approaches are set for approximately 25 mph, while the 85% speed is probably in excess of 30 mph. A left turn bay on the east approach is not matched by a turn bay on the west approach causing a centerline offset which makes it difficult for eastbound left turning drivers to see westbound thru traffic when an opposing left turn vehicle is in the bay.

A depressed drainage inlet in the southeast corner of the intersection tends to slow heavy right turn traffic movements on the northbound approach. Since a large percentage of the northbound movement is composed of right turn traffic, delays and unsafe maneuvers result.

Accidents at this intersection were not numerous, considering the high traffic volumes. There were 8 total accidents with two angle, two left turns, three rearends and a single vehicle accident.

IMPROVEMENTS

Improvements at this intersection should be completed with the intention of eliminating any possible defects and upgrading traffic control to a higher plane. Trees on the approaches should be trimmed to allow minimum sight distance to the signal heads of 250 feet. The signal heads should be replaced with new 12"x12"x12" mast arm indications and new 12"x8"x8" pole heads. MUTCD does not require this, but the larger heads increase signal visibility substantially. Only signs should be placed near the left turn signal heads where possible to assist in defining lane control when pavement markings are

not visible. The eastbound approach should be marked to include an opposing left turn bay for the eastbound approach with intent of eliminating the offset trap condition. Signal timing should be modified to included a minimum 3.5 second amber with 1.0 second all-red. All of the minimum green times on this actuated signal seem to be okay but the intersection seems to be too snappy. While driving down Arthur it is possible to see the signal turn red as many as three times. Drivers on Beckwith can see the signal go to green and then turn to amber while being within reasonable distance of making the light. In this case, the city may want to try adding some time to the passage extension and observe its operation in off-peak hours. Minimum green on Arthur could also be extended during off-peak hours so that drivers can better judge their approach to the signal.

The most costly improvement recommended at this intersection is street widening to provide a northbound right turn lane and eliminating the depressed drainage inlet. Construction of the right turn bay will reduce total intersection delay by 44% during peak hour traffic conditions. Along with improved efficiency, the new bay will eliminate unsafe maneuvers and potential conflicts. This work will also require relocation of a signal pole which affords the opportunity to replace that pole with a new pole capable of supporting a longer mast arm.

Long term improvements cannot be foreseen at this site.

ARTHUR & BECKWITH

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	8900
SOUTH APP	9400
EAST APP	6800
WEST APP	3100

EXISTING CONTROL:

NONE	
YIELD	
STOP	
SIGNAL	YES

RECOMMENDED CONTROL:

PARKING	YES
YEILD	
STOP	
WALK	
MARKING	YES
SIGNAL	YES
REGULATORY	YES

ESTIMATED COST:

TOTAL	$21990
MDoT FUND	$2990
CITY FUND	$19000

% ACCIDENT REDUCTION:

	NUMBER	PERCENT
INJ/FTL	1.4	47%
PDO	1.6	32%

BENEFIT/COST RATIO: 3

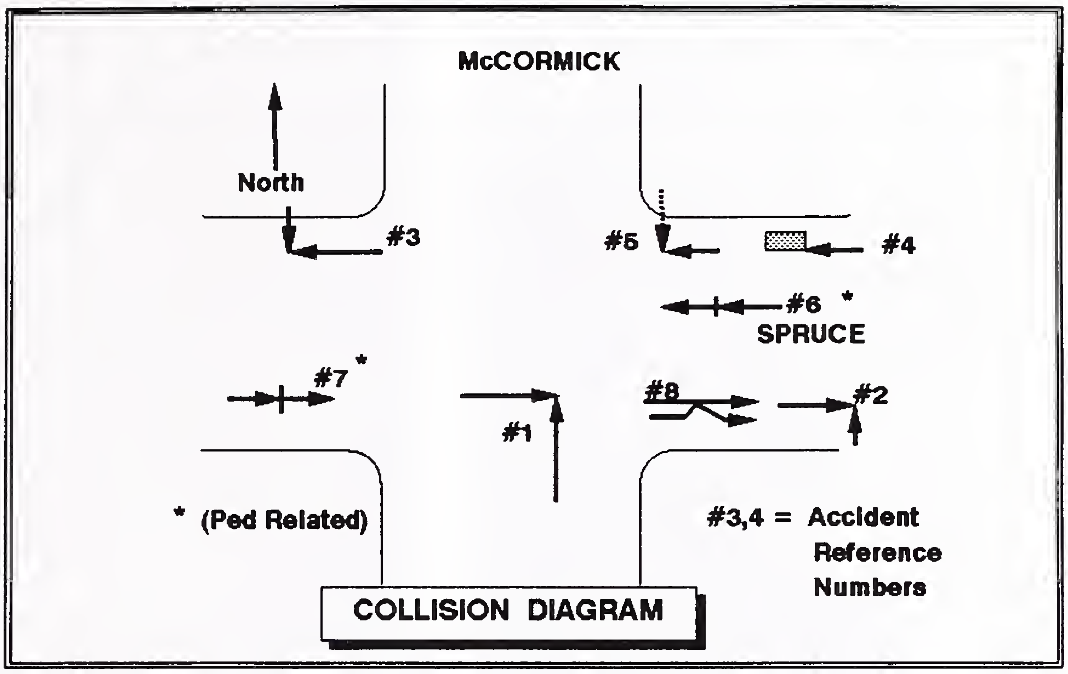
	INDEX VALUE	SITE RANK
# ACCIDENTS	61	9
ACCIDENT RATE	11	24
SEVERITY	55	6
VOL/CAPACITY	75	10
SIGHT DIST.	42	22
DRIVER EXPECT	71	11
INFO DEFICIENT	71	6
HAZARD INDEX	50.8	21
B/C RATIO	22	21

PRIORITY	41.3	23

SITE NUMBER 24

SPRUCE and McCORMICK

ACCIDENT SUMMARY
SPRUCE & McCORMICK



ACCIDENT KEY

ACC NO.	ACCIDENT TYPE	MO.	DAY	YEAR	TIME	SEVERITY	WEATHER	ROAD	LIGHT
1	ANGLE	11	22	88	1609	PROP DAM	CLEAR	WET	DAY
2	ANGLE	9	25	89	1409	PROP DAM	CLEAR	DRY	DAY
3	ANGLE	4	8	91	852	PROP DAM	CLEAR	WET	DAY
4	PARKED VEH	3	31	89	2310	PROP DAM	CLEAR	DRY	NITE
5	PEDESTRIAN	10	16	91	1959	INJURY	RAIN	WET	NITE
6	REAREND	5	18	90	1932	PROP DAM	CLEAR	DRY	DAY
7	REAREND	11	4	91	1542	PROP DAM	RAIN	ICY	DAY
8	SIDESWIPE	11	21	90	1444	PROP DAM	CLEAR	WET	DAY

ACCIDENT STATISTICS

NO. ACC.	YEAR		
1	1988	#INJ ACC	1
2	1989	#FAT ACC	0
2	1990	#PDO ACC	7
3	1991	PERSON =	1 *
8	TOTAL	NIGHTIME	25%

* No. of Persons Injured

TYPES	NUMBER	ROAD	
ANGLE	3	DRY	38%
REAR END	1	WET	50%
SIDESWIPE	1	SNOW	0%
LEFT TRN	0	ICE	13%
OTHER	3	OTHER	0%

Looking North

McCORMICK

Looking South

Looking East

SPRUCE

Looking West From McCormick

TRAFFIC OPERATIONS

Spruce Street is an east-west collector street and McCormick is a local north-south street. Spruce has traffic volumes approximately four times that of McCormick. The intersection is located in a medical corridor area and the hospital is located in the southeast corner of the intersection. The most striking physical feature at this site is the wide boulevards on Spruce. The boulevard area is 25 feet wide with tree & lawn landscaping. Because of this, the stop signs are located behind the sidewalks. In this situation, the stop signs are located a full 40 feet from the intersecting street's curbline. Vehicles on McCormick would necessarily have to stop well in advance of the stop sign in order to have a chance at seeing oncoming Spruce Street traffic and in some situations, two vehicles would be able to park in front of the sign. The signs were undoubtedly install in back of the walk to account for pedestrians, but a situation where pedestrians must cross in back of and in between vehicles is also not desirable. The parking setbacks from stop signs are only twenty feet probably due to location of the signs. The southbound stop sign is also slightly faded.

Parking demand at this location is extremely high. Any available on-street parking spaces are occupied almost 100% of the time. Many areas in and around the intersection are marked for no parking and vehicles crowd this area, but no one appears to violate these restrictions.

There were eight accidents at this intersection, three of which were angle accidents. Two rearend accidents and a pedestrian accident were all related to pedestrian traffic in and near the intersection.

IMPROVEMENTS

An honest attempt was made to restrict parking on Spruce near the corners. However, a dynamic vehicle model based on Spruce Street speeds and average acceleration values indicates that the parking setbacks would have to be nearly three times as long to allow a vehicle to cross Spruce without conflict. Since this would eliminate valuable parking spaces, an alternative is

recommended that would reduce the required setback distance and improve the conflicts with pedestrian crossings and stop sign setbacks. It is recommended that the curb line on Spruce Street be moved in toward the center, 6 feet on each side of the intersection, for a minimum distance of 40 feet and the sidewalks be reconstructed to the new curb radius points. This would allow pedestrian crossing points at the edge of the curblines and allow ideal placement of stop signs. Some parking would be lost on Spruce, but would be offset by increased parking on McCormick. Pedestrian visibility and crossing time would be improved significantly. Sidewalk alignment, as shown on the improvement sketch, could be varied to provide a more defined transition at the intersection. Additional costs would be associated with the transition of sidewalks through the boulevard to the curb radius points. Convenience for pedestrians and esthetics may want to be considered during design of these improvements.

Other improvements would consist of centerlines and stop bars on McCormick to provide operational guidance. Crosswalk markings and signing should be installed on Spruce not because of the high volume pedestrian activity, but the potential for impaired and aged pedestrians at this location is great.

All possible guidance and safety features must be considered in areas around hospitals primarily due to the fact that a larger percentage of drivers and pedestrians are preoccupied with other situations than traffic. In every safety study completed in Montana, there has been an accident site adjacent to a hospital. Unfortunately, traffic planning in development of hospital construction has not sufficiently addressed increased safety needs in these areas. At present, accident experience in this medical corridor area has not been severe. Judging by the intensity of on-street parking in the area, it may only be a matter of time before severe problems develop. As a long term solution, it is recommended that any further growth in the medical area be accompanied by a comprehensive traffic plan with emphasis on safety and special traffic needs in hospital corridor areas.

SPRUCE & McCORMICK

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	850
SOUTH APP	1900
EAST APP	7800
WEST APP	6600

EXISTING CONTROL:

NONE	
YIELD	
STOP	YES
SIGNAL	

RECOMMENDED CONTROL:

PARKING	YES
YEILD	
STOP	YES
CURB/WALK	YES
MARKING	YES
WARNING	YES
REGULATORY	

ESTIMATED COST:

TOTAL	$7,845
MDoT FUND	$2,005
CITY FUND	$5,840

% ACCIDENT REDUCTION:

	NUMBER	PERCENT
INJ/FTL	0.0	60%
PDO	3.1	44%

BENEFIT/COST RATIO: 3

	INDEX VALUE	SITE RANK
# ACCIDENTS	61	11
ACCIDENT RATE	17	21
SEVERITY	41	23
VOL/CAPACITY	55	12
SIGHT DIST.	92	15
DRIVER EXPECT	58	19
INFO DEFICIENT	58	19
HAZARD INDEX	48.1	23
B/C RATIO	24	19

PRIORITY	40.2	24

SITE

NUMBER

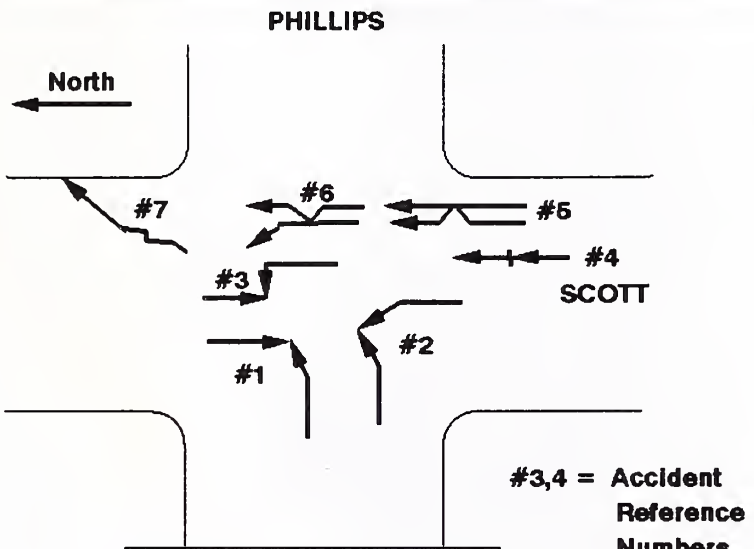
25

SCOTT

and

PHILLIPS

ACCIDENT SUMMARY
SCOTT & PHILLIPS



COLLISION DIAGRAM

ACCIDENT KEY

ACC NO.	ACCIDENT TYPE	MO.	DAY	YEAR	TIME	SEVERITY	WEATHER	ROAD	LIGHT
1	ANGLE	12	9	89	1309	PROP DAM	CLEAR	WET	DAY
2	ANGLE	5	31	91	1247	PROP DAM	CLEAR	DRY	DAY
3	LEFT TURN	3	20	90	1324	PROP DAM	CLEAR	DRY	DAY
4	REAREND	4	10	91	155	PROP DAM	CLEAR	DRY	NITE
5	SIDESWIPE	11	17	88	1549	PROP DAM	CLEAR	WET	DAY
6	SIDESWIPE	10	8	89	1212	PROP DAM	CLEAR	DRY	DAY
7	SINGLE VEH	12	3	89	1424	PROP DAM	RAIN	ICY	DAY

ACCIDENT STATISTICS

NO. ACC.	YEAR		
1	1988	#INJ ACC	0
3	1989	#FAT ACC	0
1	1990	#PDO ACC	7
2	1991	PERSON =	0 *
7	TOTAL	NIGHTIME	14%

* No. of Persons Injured

TYPES	NUMBER	ROAD	
ANGLE	2	DRY	57%
REAR END	1	WET	29%
SIDESWIPE	2	SNOW	0%
LEFT TRN	1	ICE	14%
OTHER	1	OTHER	0%

Looking North From Phillips

SCOTT

Looking South

Looking East

PHILLIPS

Looking West

TRAFFIC OPERATIONS

Both Scott and Phillips Streets are collector type streets. East of Scott, Phillips only extends for two blocks and has only minor traffic volumes compared to other traffic movements at this intersection. The intersection is located at the bottom of an extended grade to the north where Scott crosses the railroad tracks on a high overpass. Phillips Street is the first intersection with Scott south of the tracks. There are heavy turning movements at this intersection the most significant of which is the northbound left turn along with eastbound lefts and rights.

Stop sign visibility on the approaches is not a problem at this intersection. Sight distance from the stopped position is extremely significant in the operation of this intersection. Parking on Scott north of the intersection is prohibited, but huge tree trunks located behind the curb and sidewalk on both sides of the street effectively block sight distance to the north. This situation is so obvious to the typical driver that most of his attention is focused on seeing around those trees and other important vehicle operation requirements sometimes suffer. Parking restrictions on the south side of the intersection are painted according to ordinance, but are not entirely sufficient for site conditions.

There were seven accidents at this site during the reporting period. During initial inspection of these accidents, no apparent pattern could be seen because of the variety of types. After careful analysis it became evident that most of these accidents are related to northbound left turning traffic. Since Scott Street appears to be oriented to thru traffic and the overpass is an ominous roadway feature for drivers in the northbound direction, most drivers don't expect to encounter an intersection, much less a left turning vehicle at the base of the structure. Thus, reaction to this event sometimes result in rearend accidents and sideswipes (trying to change lanes) as well as left turn collisions.

IMPROVEMENTS

Since the expectancy of left turning traffic is deficient at this intersection and left turn volume exceeds 30% of total northbound traffic, it is recommended that a left turn bay be installed for this movement. The left turn bay will require removal of parking for an adequate distance south of the intersection which will vastly improve sight distance, in addition to increasing driver expectancy.

Because a park exists in the southwest corner of this intersection, it is also recommended that pedestrian crossings be established on the east and west sides of the intersection. This would allow use of stop bars closer to the intersecting street to improve vehicle stop positioning and visibility from Phillips. No formal crossing of Scott is required or desirable at this intersection.

Long term improvements at this location first require removal of the large trees north of the intersection. This action would give drivers the opportunity to refocus their attention on other aspects of the intersection's operation. If traffic volumes increase to any significant degree which would cause traffic signal warrants to be met, a higher type intersection design may need to be considered.

SCOTT & PHILLIPS

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	5500
SOUTH APP	6000
EAST APP	300
WEST APP	3800

EXISTING CONTROL:

NONE	
YIELD	
STOP	YES
SIGNAL	

RECOMMENDED CONTROL:

PARKING	YES
YEILD	
STOP	YES
WALK	YES
MARKING	YES
WARNING	YES
REGULATORY	

ESTIMATED COST:

TOTAL	$4805
MDoT FUND	$3445
CITY FUND	$1360

% ACCIDENT REDUCTION:

	NUMBER	PERCENT
INJ/FTL	0.0	0%
PDO	3.8	51%

BENEFIT/COST RATIO: 1.6

	INDEX VALUE	SITE RANK
# ACCIDENTS	58	14
ACCIDENT RATE	17	22
SEVERITY	34	25
VOL/CAPACITY	88	4
SIGHT DIST.	100	9
DRIVER EXPECT	75	7
INFO DEFICIENT	50	21
HAZARD INDEX	51.2	19
B/C RATIO	10	25

PRIORITY	37.6	25